



QC

53

R59



Library of Congress.

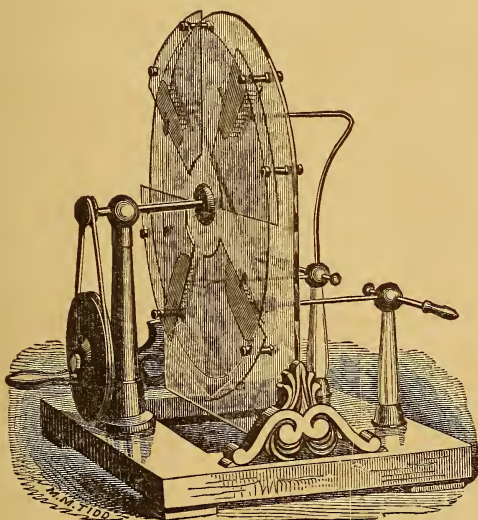
Chap. ... QC 53

Shelf. .R 59

Copyright No.

UNITED STATES OF AMERICA.

RITCHIE'S
CATALOGUE
OF
SCHOOL APPARATUS.



E. S. RITCHIE & SONS,

No. 149 TREMONT STREET,

BOSTON.

1869.

17265
RITCHIE'S

#7265

ILLUSTRATED CATALOGUE

OF

SCHOOL APPARATUS.

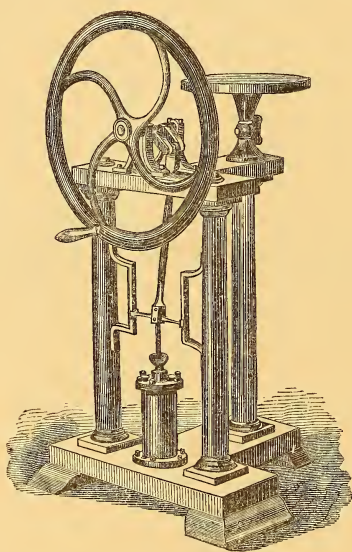


BOSTON:

149 TREMONT STREET.

1869.

©



RITCHIE'S ROTARY AIR PUMP.

Entered, according to act of Congress, in the year 1869, by

E. S. RITCHIE & SONS,

In the clerk's office of the District Court for the District of Massachusetts.

8253
P 59

Advertisement.

TERMS, CASH. No discount or deviation can be made from Catalogue prices ; and those who favor us with orders by mail may rely on receiving instruments as good in quality, and at the same price, as if they came personally.

We have no Agents, nor are our Instruments for sale by any others. We fix our prices as low as we can afford for the quality of our work, and leave no margin for *discounts* to those who buy to sell again. We wish, also, that our instruments be received by the purchaser in perfect order.

Drafts at sight, to our order, on New York or Philadelphia, received at par ; for small sums, post office money orders are convenient.

A charge of two per cent. for boxing, packing, and delivery at railroad station will be added to the bill.

We will deliver *free of freight* to the nearest railroad station, and *insure against loss and breakage* by transportation to any purchaser, either of the sets, or a similar selection from this Catalogue, *provided* that a draft is received *previous* to shipment of order, and that the amount is not less than one hundred dollars.

For testimonials from the highest sources, to the quality of our work, and for our responsibility, we refer to letters at the close of Catalogue.

Great care will be used in packing, but unless we *insure*, our responsibility must end with delivery to the public carrier. Our charge for insurance for average risk is two and a half per cent.

RITCHIE'S CATALOGUE OF
Philosophical Instruments,

WILL BE SENT ON APPLICATION.

PREFACE.

THE following Catalogue has been prepared of Apparatus especially adapted for the requirements of the Grammar and High Schools of the country. It has chiefly been compiled from our Catalogue of Philosophical Instruments, with some new instruments which we have devised and constructed for the purpose.

The aim has been to select articles that each will illustrate a Principle in the simplest and clearest manner; to adopt the size best uniting efficiency with economy; to avoid multiplying experiments illustrating the same principle; and to omit such as are beyond the intended range.

The instruments enumerated in this Catalogue are almost exclusively of our own manufacture. We shall adhere strictly to our rule, that everything shall be thoroughly well made and finished, of best materials, and carefully adjusted; and every article is warranted to be so, and to correspond to the description.

Particular care is given to the lacquering, which is done in a manner that will resist the action of the atmosphere, and bear use and handling for a long time untarnished.

E. S. RITCHIE & SONS.

EDWARD S. RITCHIE. }
THOMAS P. RITCHIE. }
JOHN RITCHIE.

RITCHIE'S

CATALOGUE

OF

SCHOOL APPARATUS.

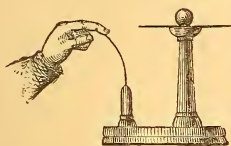
LAWS OF MATTER AND MECHANICS.



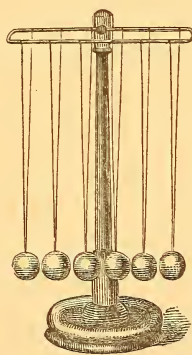
No. 1.



No. 2.



No. 3.

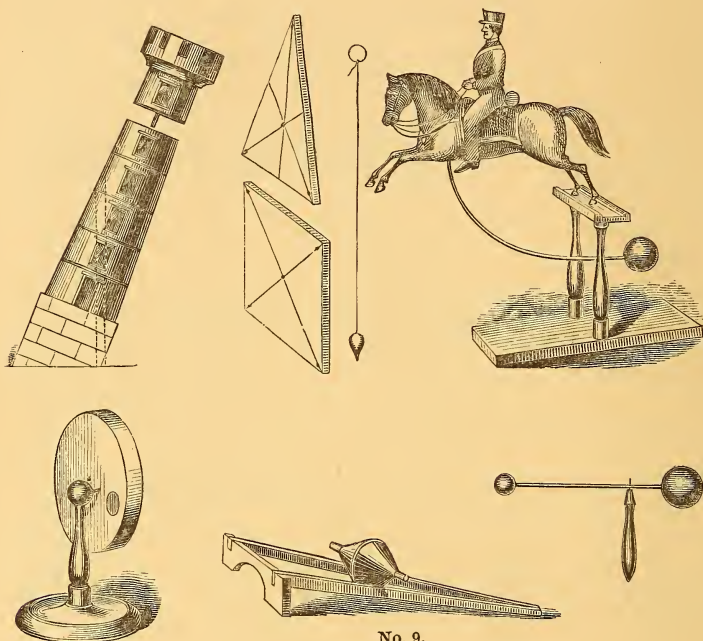


No. 7.



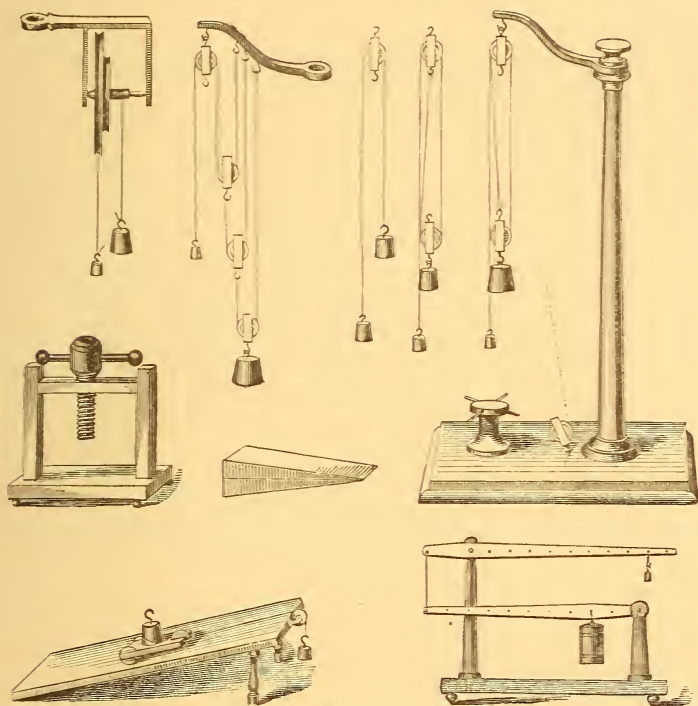
No. 8.

No.		Price.
1.	Adhesion Plates; a pair of ground glass plates, with handles,	\$1.25
2.	Lead Hemispheres, for adhesion. Scrape the surfaces bright, and press them firmly together, at the same time moving one slightly on the other,	1.00
3.	Inertia Apparatus; stand, with spring and ball,	1.75
4.	Capillary Tubes; a set of six glass tubes of different calibre, in a box, . . . . .	.50
5.	Capillary Tubes; six tubes sealed into a bar to rest upon a tumbler,	1.00
6.	Capillary Plates; of plate glass with elastic band. Separate them at one edge slightly, and set them upright in a plate of water,	1.50
7.	Collision Balls; a base and pillar, with a frame sustaining five lignum-vitæ balls with double cords,	6.50
8.	Collision Balls; a set of five lignum-vitæ balls, $1\frac{1}{2}$ inch diameter, suspended upon a metallic bar which is fitted to attach to the pillar of the set of <i>Mechanical Powers</i> , (see cut No. 12,)	3.50



No. 9.

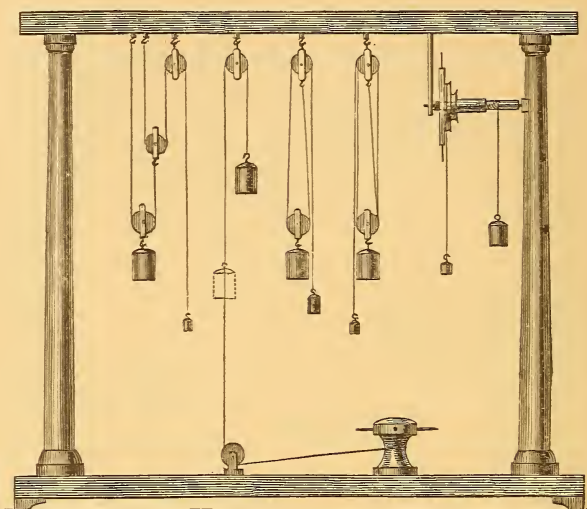
No.		Price.
9.	Centre of Gravity ; a set of illustrations of centre of gravity, viz.:	
1st.	Triangular block, with holes drilled at the angles, from which lines are drawn, representing the verticals through the several points of support and the common centre of gravity.	
2d.	A square block, with similar centres and lines.	
3d.	An oblique parallelogram, with centres and lines.	
4th.	Two balls of unequal size, with centre in the connecting rod. A handle, with steel pin for the above.	
5th.	Plumb line.	
6th.	Loaded wheel and stand; a disk of wood which has a mass of lead inlaid near one edge, with centres of magnitude and gravity.	
7th.	Leaning tower, with movable capital and inclined base; with the capital removed, the vertical of the centre of gravity falls within the base; replace the capital, and the vertical falls beyond the base, consequently the tower falls; the centres are drilled to balance upon the stand of 6th illustration.	
8th.	Double cone and inclined plane; the cone rolls up the inclined plane, the bars of which diverge so that the axis of the cone actually descends.	
9th.	Horse and rider, with lead ball and stand; adjusted to balance on the legs of the horse.	10.00
10.	Centre of Gravity. A set of illustrations selected from No. 9.	
1st.	Triangular block.	
3d.	Oblique parallelogram.	
4th.	Balls and rod.	
6th.	Loaded wheel.	
7th.	Leaning tower.	
8th.	A handle for 4th and 6th. . .	5.00



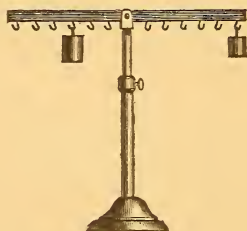
No. 11.

- | No. | Illustration of Pulleys, and Wheel and Axle. | Price. |
|------|--|--------|
| 11. | A mahogany base and pillar, with a screw and nut to confine a bar with hooks for the following systems; the pulleys are of brass; in the double ones the wheels are separated by partitions; all the systems are balanced. | |
| 1st. | Fixed pulley and cord; power and weight equal. | |
| 2d. | Fixed and movable pulleys, power and weight as 1 to 2. | |
| 3d. | Double movable pulleys, power and weight as 1 to 4. With the pulleys, the "system of four single pulleys" can be made, and cords fitted and sent with the set; power and weight as 1 to 2, 4, or 8. | |
| 4th. | Wheel and axle, with four diameters, and cords, suspended in a frame to attach to the pillar. | |
| 5th. | Ship's capstan and levers; a hook is placed in the basement to secure a fixed pulley; pass the cord over a pulley on the bar. | |
| 6th. | Cords fitted for making the "system of four single pulleys," by using those of the above sets. | |
| 7th. | A set of weights from 1 to 32 ounces. | 20.00 |
| 12. | Simple and Compound Levers. Mahogany base and pillars; the levers are balanced by a riding weight. | 5.50 |
| 13. | Wedge, Inclined Plane, and Screw. Inclined plane and car, the cord passes over a pulley for the weight; screw in frame, with lever; wedge; all of mahogany. | 7.50 |
| 14. | Set of Mechanical Powers, including Nos. 11, 12, 13. | 33.00 |

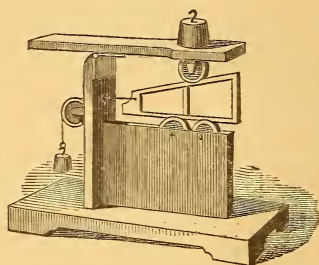
NOTE.— This arrangement for the illustration of the *simple machines* will be found very convenient and complete. The teacher can thus have before his class those *only* that illustrate the lesson, which he can show in a conspicuous manner.



No. 15.

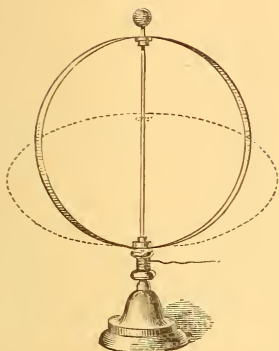


No. 16.

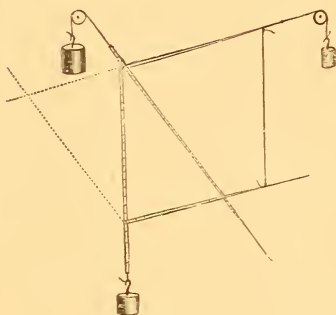


No. 17.

- | No. | Price. |
|---|--------|
| 15. Illustration of Pulleys; polished mahogany base, pillars and bar, supporting the four following systems of pulleys, wheel and axle, and capstan. The pulleys are large, with improved straps, with divisions, strung with silk cord and balanced. | |
| 1st. Fixed Pulley and cord; power and weight equal. | |
| 2d. Fixed and Movable Pulleys, power and weight as 1 to 2. | |
| 3d. Double Fixed and Movable Pulleys, power and weight as 1 to 4. | |
| 4th. System of four Single Pulleys, power and weight as 1 to 2, 4 or 8. | |
| 5th. Wheel and Axle, with four diameters, and cords. | |
| 6th. Capstan and Levers. | |
| A set of brass weights from one to thirty-two ounces. | 35.00 |
| 16. Lever Balance and Steelyard; base and brass pillar, mahogany beam with steel knife edges, and hooks for weights. | 10.00 |
| 17. Illustration of the Wedge; mahogany frame, brass wedge, with friction rollers; the upper bar and roller are balanced; a pulley and cord for the power; the length of the wedges is to the height as 4 to 1. . . | 7.50 |



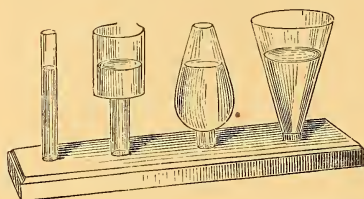
No. 18.



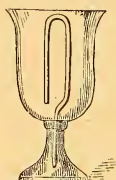
No. 19 A.

- | No. | Price. |
|---|--------|
| 18. Central Forces ; a heavy metal stand and spindle, on which revolves an elastic ring, with a spool attached for a cord to be wound upon; the ring in rapid motion assumes the form of the dotted line in consequence of the <i>centrifugal</i> force; the spring of the metal tending to counteract this force represents the <i>centripetal</i> force, | \$3.75 |
| 19. Gyroscope ; a brass ring or wheel upon an axis, supported by a ring with ears to rest upon a point and stand; the motion of this instrument is the resultant of the force of <i>inertia</i> , by which revolving bodies tend to remain in the same <i>plane</i> , combined with the force of <i>gravity</i> ; these two forces produce a horizontal motion around the point of support. Curiosity is excited by the motion of this instrument, because it does not <i>fall</i> ; the force of <i>gravity</i> united with another force, which is <i>not apparent</i> , changes the motion to another <i>direction</i> . This instrument is hardly suitable for <i>illustration</i> in schools, | 3.50 |
| 19 A. Parallelogram of Forces ; a light graduated frame with hinged joints; two of the pulleys of No. 12 should be fixed to the blackboard, three or four feet apart; the cords from two of the bars pass through these pulleys to weights, which represent the direction and intensity of two <i>forces</i> acting on the point of attachment; the longer bar is graduated below the hinge to equal parts. A third bar, hinged at the same point, represents the direction, and a weight attached the intensity of the <i>resultant</i> force; this bar is graduated to the same scale; a fourth graduated bar is attached to the third, and is suspended so as to be always parallel to the shorter of the first pair. The readings of the graduated bars will always correspond to the intensity of the forces, and the enclosed space forms the <i>triangle of forces</i> from which the parallelogram can be drawn. | 7.50 |
| 19 B. Illustration of the Pendulum , a bar to attach to the pillar of No. 12. Two pendulums of equal length, with balls of lead and boxwood, which oscillate in the same <i>time</i> , showing that this is not affected by the length of the arc of vibration, nor by the weight or density of the ball; two other pendulums, of one fourth and one ninth the proportional length, which oscillate in one half and one third the time, proving that the time of a pendulum is as the square root of the length. . | 3.50 |

HYDROSTATICS.



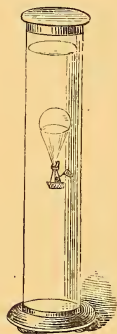
No. 30.



No. 25.



No. 22.

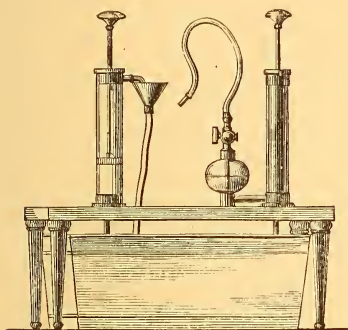


No. 26.



No. 27.

- | No. | | Price. |
|-----|--|--------|
| 20. | Equilibrium Tubes , or hydrostatic paradox; four glass vessels of different forms, connected by a tube within the base, showing that a liquid preserves a level. | 3.50 |
| | NOTE.— Pour into one of the tubes enough of alcohol to fill it, displacing the water; the column of alcohol will stand as much higher as its <i>specific gravity</i> is less. | |
| 21. | Bottle and Tubes . A closed jar with three tubes, opening upward, downward, and laterally, to show that the pressure is equal in each direction at same depth. | 3.50 |
| 22. | Glass Cylinder and Plate , to illustrate the upward pressure of liquids; the tube is ground to fit the heavy brass plate; hold the plate up by the string, and plunge the cylinder in water; the pressure below will then sustain it. | 3.00 |
| 23. | Liquid Adhesion Plate . A glass disk with cord; considerable force is required to lift it from the surface of water; the water below the plate will be raised considerably above the level in the vessel. | 1.50 |
| 24. | Siphon of glass tube | .50 |
| 25. | Tantalus Cup , illustrating intermitting springs; fill the cup slowly; when the water rises to the bend of the siphon, it will flow and empty the cup. | 2.00 |
| 26. | Glass Balloon and Car , in jar; the balloon is partly filled with water; by pressing down the elastic cover, the air above the water is compressed, and transmits a pressure to the water, by which the air in the balloon is also compressed, and more water is forced in through an orifice, increasing its weight so that it sinks; remove the hand, the air within the balloon expands, water is expelled, and the balloon rises. This simple apparatus strikingly illustrates the <i>compressibility</i> and <i>elasticity</i> of the air, and the principles of <i>specific gravity</i> | 5.00 |
| 27. | Model of Lifting Pump . A strong glass cylinder with brass caps, showing the action of the piston and valves. | 9.00 |



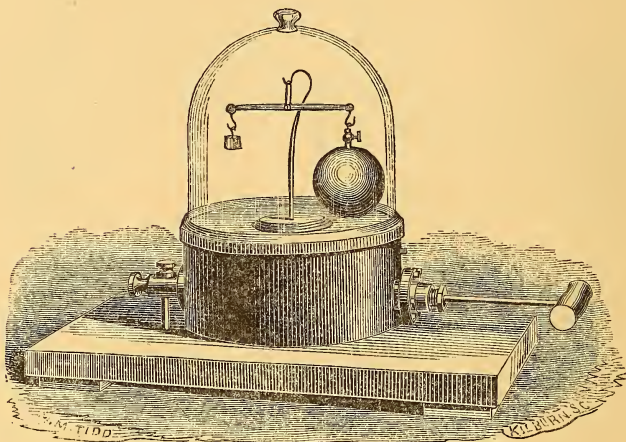
No. 28.



No. 29.

- 28. Model of Lifting and Force Pumps.** Lifting and force pumps on a mahogany stand, with large cistern.
The cylinder of the lifting pump is of glass, showing clearly the piston and valves; a funnel and tube conveys the water again to the cistern. The force pump is also of glass, with glass air-chamber; the piston and both valves are visible in action; the condensing-chamber has a stopcock and hose, with jet. 22.50
- 29. Archimedes' Principle.** A brass cylindrical cup, with a bail and hook beneath; a cylinder of brass exactly filling the cup; and counterpoise; suspend the cup with the cylinder enclosed and counterpoise to balance of No. 56; then suspend the cylinder by a thread to the hook, and let it be immersed in a tumbler of water, and fill the cup with water; it will again be balanced by the counterpoise, proving the buoyancy of a liquid to equal the weight of the same volume. 2.50
- 30. Model of Water Wheels,** overshot, undershot, and breast wheels, with water-course neatly made of tin, and painted. 12.00
- 31. Hydrometers.** Baumé's scale for spirit, acids, milk, syrup, &c; 1.25 and 1.00
- 32. Hydrometer,** universal, with 0 in the middle of the scale. 2.50
- 33. Hydrometer,** Nicholson's, for specific gravity of solids. 6.00
- 34. Ritchie's Illustration of the Hydrostatic Press.** A frame of brass; within the base is placed a cylindrical, bellows-formed bag of rubber, connected by a tube to a rubber globe, fitted with a cap; a cylinder of iron, $2\frac{1}{2}$ inches diameter and 4 inches high, rests upon the bag. Fill the globe with water, close the cap, and elevate the globe of water; the hydrostatic pressure of the column of water will force it into the bag, raising the iron cylinder; depress the globe, the weight will force the water back into the globe. 9.00
- 35. Specific Gravity Balance.** A brass beam and scale-pans, brass stand-ard and base. 1.00
- 36. Model of Barker's Mill.** Metal tube, and funnel to attach to No. 65. . 1.25
- 37. Hero's Fountain.** 24 inches high, with jet. 8.00

PNEUMATICS.



No. 40.

- | No. | | Price. |
|--|--|--------|
| 40. | Ritchie's School Air Pump. The plate is eight inches diameter, and forms the top of a cylinder four inches high, which prevents any flexure or change in its form. The pump cylinder is placed horizontally beneath the plate, passing through its cylinder which protects it from injury. The inlet tube from the plate into the pump is of large diameter, and opens into the cylinder below the piston when fully drawn out, allowing a free communication from the receiver to the pump, without valve or obstruction. The piston is of a new construction, and is packed so as to move freely, yet is perfectly tight, and will wear a long time uninjured; the exit valve is simply a disc of oiled silk, held in place by a pin in the middle, and covered by a brass dome; the valve can be changed if required, in a minute's time. The exit valve tube passes to a cistern below. The base is of mahogany, and is furnished with a table clamp screw. | |
| | This pump is essentially automatic in action, and will produce a vacuum more than twice as high as <i>any pump in which the valves are raised by the air</i> ; this is of great importance in all experiments of electricity in vacuum. It is worked with ease, and is warranted to be trustworthy and durable. A patent has been applied for. | 25.00 |
| 41. | Ritchie's Patent Air Pump, with automatic action. The form of the pump is similar to No. 42 (see <i>Cut</i> on page 14), with base, pillar and lever; the plate is 12 inches in diameter; cylinder $7\frac{1}{2}$ inches by $2\frac{1}{2}$ in diameter; a full description of the construction and the operation of the piston and valves, with cuts, is given on the next page. The friction of the piston is very slight, and the pump is worked with great ease, while the rarefaction obtained is higher than has been reached by any other pump. | 100.00 |
| NOTE.—In our larger catalogue will be found a description of a large pump, with rotary action. See <i>Cut</i> on page 2. | | |

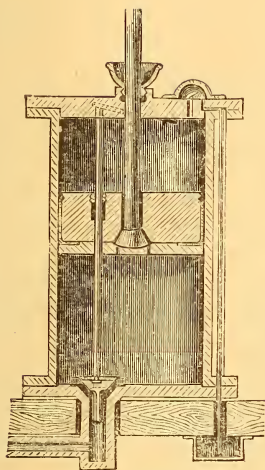


Fig. A.

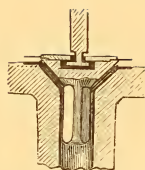


Fig. B.

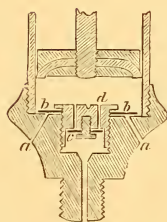


Fig. C.

DESCRIPTION OF RITCHIE'S PATENT AIR PUMP.

Fig. A is a section showing the valves, &c., much exaggerated, for distinctness.

The lower valve is conical, held in place by a triangular stem fitting the tube; it is raised by the valve-rod passing up through a stuffing-box in the piston; an enlarged section (fig. B.) shows the manner in which the attachment is made, which allows a motion of the rod sidewise, so that any slight change of form of the packing of the piston, or stuffing of the rod, cannot prevent the valve from shutting properly. The cone of the valve is ground to a perfect fit to its seat, but the valve is also furnished with a disk of oiled silk which projects just beyond its outer edge, and touches the flat surface of the valve seat; the valve-rod extends up, and its upper end is secured in a hole drilled in the upper plate, of depth to allow motion to open the valve.

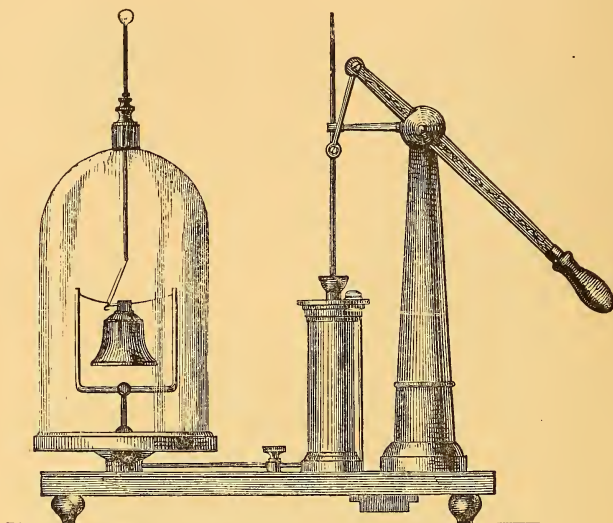
The piston is of thick brass, made in two parts; the upper piece has a hole drilled larger than the piston rod; the lower part of conical form, ground to fit a cone on the piston-rod; this forms the piston-valve. The lower piece of the piston covers the end of the piston-rod, but allows it enough motion to open the valve; a series of small holes through the plate gives a free passage for the air to the valve.

A third valve is placed outside the cylinder, made of oiled silk in the usual way.

In the thickness of the upper plate of the cylinder is inserted a steel lever, one end of which covers the valve-rod; the other end, when the lower valve is closed, is flush with the plate; but when the valve is raised, it projects into the cylinder.

In action, the first motion upward of the piston-rod closes the piston-valve; the first motion of the piston opens the lower valve; as the piston ascends, the air above it is forced out through the upper valve; and air from the receiver flows unobstructedly into the cylinder. The piston strikes the tail of the lever, and at the instant of arriving at the top, closes the lower valve. The first downward motion of the piston-rod opens the piston-valve, and the small quantity of air remaining in the interstices above the piston is distributed throughout the cylinder, but none can flow into the Receiver, when the piston reaches the bottom, the interstices below contain air as rarefied as an ordinary pump can exhaust; the next upward stroke must leave almost a perfect vacuum below; and as there is no obstruction to the receiver, it must by continued action be brought to the same degree of exhaustion. The working parts are very substantial, not likely to be deranged, and are readily accessible.

The result is, that almost a *Torricellian* vacuum is obtained; a true mercury gauge can be brought to within one fiftieth of an inch. The Aurora Tube with the discharge of an Induction Coil, or Holtz machine, is filled with brilliant stratified light.



No. 42.

- | No. | Price. |
|---|--------|
| 42. Air Pump, of Ritchie's improved construction, on Leslie's principle, with lever, and closed cylinder, by which the pressure of the atmosphere is in a great degree removed from the piston. The cylinder is highly polished; the piston rod passes through a stuffing box of cup form, which is to be half filled with oil; the outer valve is of original construction, similar to the one adopted in No. 40. The dome, covering the valve as well as the cylinder head, can be readily unscrewed by the hands. The exit tube passes from a channel round the valve through the base into a cistern, to receive any oil that may pass over. Oil cannot accumulate upon the valve as in the old form. The base is 20 by 14 inches, cylinder $7\frac{1}{2}$ by two inches, plate 8 inches in diameter. | 45.00 |
| 43. Swelled Receivers. One gallon, 2.50; two gallons, | 3.50 |
| 44. Plain Receiver (<i>See cut No. 40</i>). Quart, 1.00; two quarts, 1.25; gallon, | 2.00 |
| 45. Sliding Rod Receiver (<i>See cut No. 42</i>). One gallon receiver, with brass cap and sliding rod, complete. | 5.00 |
| 46. Cylindrical Jar to place under receiver; two quarts. | 1.50 |
| 47. Hand Glass, or Bladder Glass, ground at each end; place it upon the pump, and cover the opening with the palm of the hand; it will be forced down with a pressure of about forty pounds if the glass is entirely exhausted. Stretch a piece of thin wet bladder over the large end, tie it tightly, and let it dry; put the small end on the plate, the bladder will burst with a loud report; or tie over a piece of vulcanized rubber, it will be forced in by atmospheric pressure until it nearly fills the interior of the glass. | 1.25 |
| 48. Ritchie's Improved Condenser; the cylinder is 7 by $1\frac{1}{4}$ inches; the base cap can be unscrewed by the hand; a large screw in the thickness of the cap holds the inlet valve by its flange, while the exit valve is secured at its lower end by a pin. The valves are thus protected from injury, yet both are readily accessible; both are of oiled silk, and hold perfectly tight. (<i>See Fig. C, page 13.</i>) | 9.50 |



No. 48.



No. 50.



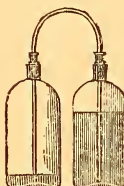
No. 51.



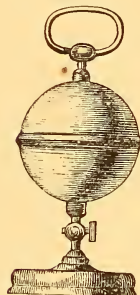
No 52.



No. 49.

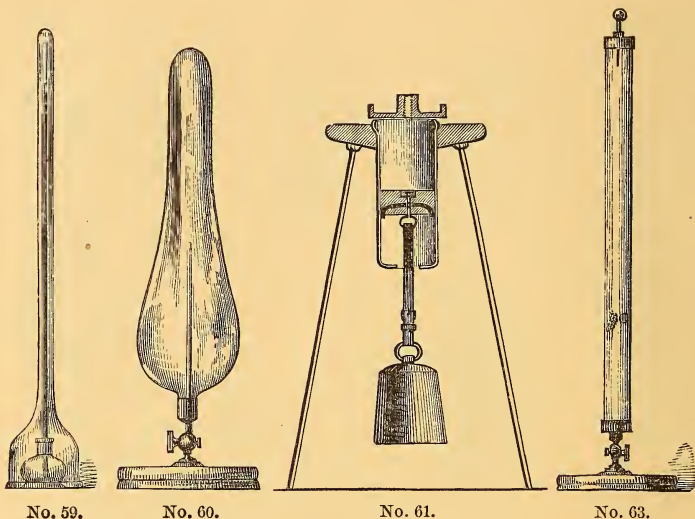


No. 53.



No. 54.

No.		Price
49.	Condensing Chamber, of heavy copper, with stopcock, movable interior tube, and water-jet.	8.50
50.	Mercury Tunnel, or Mereury Shower; a eup of mahogany with a cylinder of porous wood; place upon the <i>hand glass</i> with a tumbler below; pour some mercury in the eup; exhaust, and the atmospheric pressure will force the mereury through the pores of the wood. . . .	1.25
51.	Expansion Bolt Head, and vial; half fill the vial with water colored with litmus or red ink; place under the receiver; the air in the globe will expand, and rush out through the water; then vent the pump and the water will nearly fill the bulb. . . . .	.75
52.	Freezing Apparatus; reeiver, pan for acid, improved silvered water eup, and supporting frame. Pour a little sulphurie acid into the pan, and a little water into the eup; the water will be frozen by the rapid evaporation.	4.00
53.	Bacchus Illustration; two glass jars, a brass tube passes from the bottom of one, fitting air-tight to its brass cap, and passes over to the bottom of the other jar. Nearly fill the elosed jar with colored water, place under the receiver; the confined air in the first jar will expand and drive the water over into the other jar; then vent the pump and the water will be driven back again.	2.75
54.	Magdeburg Hemispheres, $4\frac{1}{2}$ inches diameter; stopcock, handles, and stand; serew the stopcock into the pump plate, exhaust, elose the stopcock, and serew on the opposite handle; great foree will now be required to separate the hemispheres.	7.50
55.	Rubber Bag and Cap. Put the bag, with very little air in it, under the receiver; the confined air will expand and distend the bag. . . .	2.25
56.	Weight and Buoyancy of Air (<i>See cut</i> , No. 40). Brass balance, with brass support and stand; globe of three inehes diameter, with stopcock, hook, and couterpoise.	7.50
57.	Water Hammer; a glass tube containing water in a vacuum, hermetically sealed; the water strikes with a metallie coneussion.	1.25
58.	Barometer Tube. A thiek tube 33 inches long, elosed at one end; fill with mercury, close it tightly with the finger, and plunge it under mercury in a eup; remove the finger and the mercury column will fall a little, but will remain nearly 30 inches high in the tube.	1.50

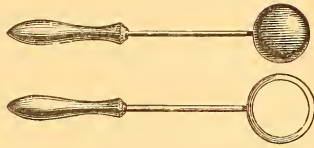


- | No. | Price. |
|---|--------|
| 59. Barometer Apparatus of improved construction. Receiver 33 inches high; a glass tube with brass screw collar fitted to a mercury cistern; the top of the cistern has a cap and oiled silk valve; exhaust and the air will pass out freely through the valve; admit the air and the mercury will rise to near the barometer height. | 6.00 |
| 60. Fountain , a heavy glass receiver 15 inches high, with cap and stopcock; a long brass jet and stand; exhaust the bell and plunge the stopcock in water, which will be forced up in a jet. | 6.50 |
| 61. Upward Pressure Apparatus . A glass cylinder supported upon a tripod stand, with piston and strap for weight; the top of the cylinder is closed by a plate, which is to be connected to the air-pump by the hose No. 62. Exhaust, and the piston will be forced up by the atmospheric pressure. | 11.00 |
| NOTE.—The <i>upward</i> and <i>lateral</i> pressure of the air is as strikingly illustrated by the Magdeburg hemispheres. | |
| 62. Rubber Hose , with brass screws to connect No. 61 to air-pump. | 3.00 |
| 63. Guinea and Feather Tube . A heavy glass tube with brass caps, stopcock, and stand; a thin disk of metal and several of tissue paper are enclosed; exhaust, and then elevate alternately each end of the tube; the tissue paper disks will fall as rapidly as the metal one. The tube is fitted with a point for an <i>Aurora Tube</i> . (See No. 131.) | 8.00 |
| 64. Air Gun ; a brass tube with socket to fit a stopcock, to be used with the condensing chamber, with balls; drop a ball into the tube, quickly turn the stopcock half round, enough air will escape to throw out the ball with great force. | 1.25 |
| 65. Revolving Jet , with screw to attach to the <i>Condensing Chamber</i> . When used as a <i>Barker's Mill</i> , leave off the interior tube, and invert it within the jar No. 46. | 2.25 |
| 66. Wood Cylinder and Weight , to sink when the air is removed from the pores of the wood. | .25 |
| 67. Plate Paradox . A brass plate and tube, and mica disk; lay a disk upon the plate, and it cannot be blown off. | .75 |
| 68. Washers for stopcocks, &c. | .25 |
| 69. Oil to use with air pump. | .25 |

HEAT.



No. 70.



No. 71.



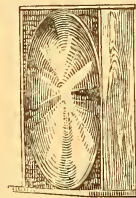
No. 77.



No. 75.



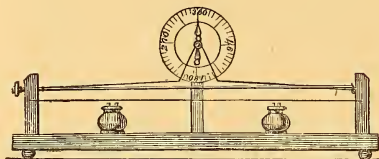
No. 76.



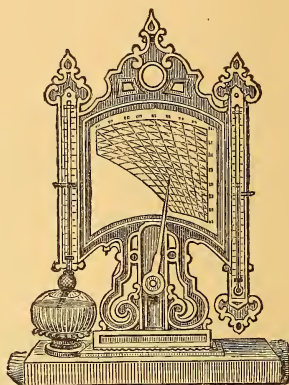
No.		Price.
70.	Palm Glass. Two bulbs and connecting tube, containing ether in a vacuum, which boils by the heat of the hand. The absorption of heat in vaporizing a portion of the ether will be sensibly felt; the bulb in the hand will feel cold.	1.00
71.	Pulse Glass. Similar to No. 70, but with one bulb; the other end is cylindrical; the heat of each pulsation in the hand is marked by a bubble formed in the tube.	1.00
72.	Ring and Ball, showing the expansion of metals by heat; the ball, when cold, passes freely through the ring; heat the ball over a spirit lamp, and it will not enter the ring.	2.25
73.	Bar and Gauge, with handles like No. 72; the bar, when of same temperature with the gauge exactly fits it; by warming the bar (or by exposing the gauge to cold), it will not enter. This apparatus is more sensitive, and better than No. 72.	2.25
74.	Compound Bar, showing the unequal expansion of different metals; a bar of iron and brass riveted together; heat the bar, and it becomes curved by the greater expansion of the brass; 1.25 and	2.25
75.	Fire Syringe and Tinder; showing the heat evolved by the sudden compression of air; a brass cylinder and piston, with a cavity for tinder; force the piston down suddenly, and the tinder will be fired. . .	3.00
76.	Reflectors and Ball. A pair of polished, silver plated concave reflectors, in a case which is divided in such manner as to form a stand for each; an iron ball with stand; heat the ball to a red heat, and place it in focus of one mirror, and place one bulb of No. 70 or No. 85 ten or twenty feet distant, in the focus of the opposite mirror, showing that heat is reflected in the same manner as light; 12.50 and	9.00
77.	Wollaston's Steam Engine. A cylinder with a thin copper globe, piston and rod, and handle; pour a little water into the globe, and hold it over a spirit lamp; steam will be generated and drive up the piston; then plunge the globe in cold water; the steam will be condensed and the piston forced down by atmospheric pressure. This is a simple but beautiful illustration of the low-pressure engine.	5.50
78.	Wire Gauze, in frame, for experiments with flame, illustrating the Davy miner's lamp. . . . .	.75



No. 87.



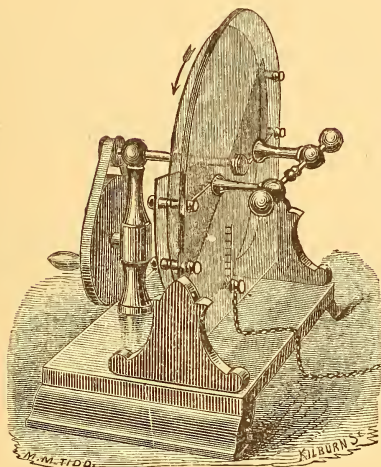
No. 86.



No. 90.

- | No. | | Price |
|-----|---|-------|
| 79. | Specific Heat. Two balls of copper and tin of equal weight; pour into two thin tumblers the same weight of water, and note the temperature by a thermometer; plunge the balls into boiling water, and then one in each of the tumblers. It will be found that the copper ball has raised the temperature highest, but that in neither is the water <i>raised</i> as many degrees as the balls have <i>lost</i> , showing that copper has <i>more</i> capacity for heat than tin, but <i>less</i> than water. | 1.75 |
| 80. | Plates for Radiation and Absorption. Two plates, one bright the other black, with stand. Heat the copper ball of No. 79, place it midway between the bulbs of No. 85, and let the plates touch the bulbs; the black will prove to be the best absorber. Place the plates in contact with the ball, and the black will be the best radiator. | 1.50 |
| 81. | Cell for Iodine. For solution of iodine in bisulphide of carbon; this solution has the property of cutting off totally all heat from a <i>luminous source</i> , while it permits obscure heat to pass freely. | 5.50 |
| 82. | Principle of Ventilation. A glass bell, with a tube or chimney, and movable diaphragm; place a short piece of a lighted candle within the bell, it will soon be extinguished; put the diaphragm into the tube, a circulation takes place, and the candle will burn brightly. . . | 3.50 |
| 83. | Thermometer in japanned case; six inch, .75; eight inch, | 1.00 |
| 84. | Thermometer for liquids. | 1.25 |
| 85. | Differential Thermometer , Leslie's, on stand, | 3.50 |
| 86. | Conductometer. Brass plate on tripod, six rods of iron, brass, tin, copper lead and glass; place it over a spirit lamp with phosphorus upon the ends of the rods. | 4.50 |
| 87. | Eolipile. A ball and jet; heat it over a spirit lamp, plunge it under water so that water will be forced in; heat until the steam issues with force; substitute ether and the jet will burn with a beautiful flame. . | 3.50 |
| 88. | Pyrometer. Mahogany frame, with dial and adjusting screw; rods of iron and brass, and two small spirit lamps. | 7.50 |
| 89. | Psychrometer , or Mason's <i>Hygrometer</i> , with fountain in boxwood scale. | 4.00 |
| 90. | Hygrodeik (Edson's); a very valuable and convenient adaptation of a scale to the <i>Psychrometer</i> , by which all calculations from the formula are saved, and the results obtained at a glance. Viz.:—1st. The actual and sensible heat of the room. 2d. The relative amount of moisture in the air on a scale of 100 degrees, zero being absolute dryness, and 100° saturation for the <i>given temperature</i> . 3d. The dew-point. 4th. The weight of water in grains present in each cubic foot of air. 5th. The force of vapor. By following the indications of this instrument, not only health and comfort will be promoted, but also economy in the saving of fuel. | 15.00 |

ELECTRICITY.



No. 99.

RITCHIE'S PATENT HOLTZ MACHINE.

One of the most remarkable inventions of late years is that of the Holtz Machine, which is an instrument for the excitement of electricity on a principle analogous to a revolving *Electrophorus*, which was the aim of the inventor whose name it bears.

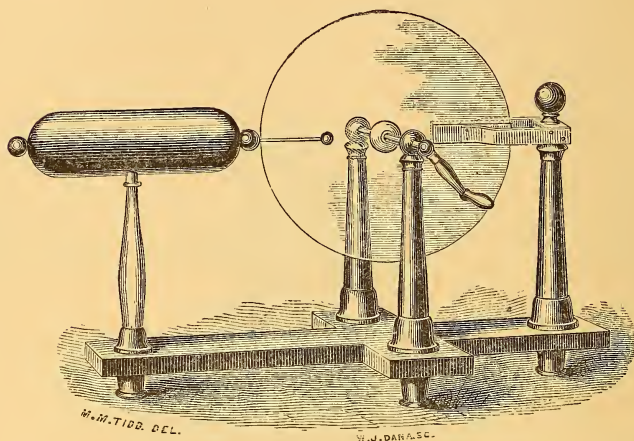
The construction and arrangement of our machine has been much changed and improved from that of the original one. It consists of a stout glass plate, supported upon a mahogany base; upon this and upon a pillar is sustained a thin revolving glass plate, over which, at opposite sides of the shaft, are two or four *sectors* of glass; on one edge of these are coatings of paper with projecting points. On the opposite side of the revolving plate from these coatings, are sets of collecting points, which are connected to two pillars, bearing sliding dischargers.

The machine is excited by bringing near to one of the sectors a piece of vulcanite which has been rubbed upon a cat's skin while the plate is in revolution; a torrent of sparks will pass between the dischargers so long as the motion is continued.

The power is immensely greater than that of a frictional electrical machine, exceeding in quantity that from a plate of several times the diameter.

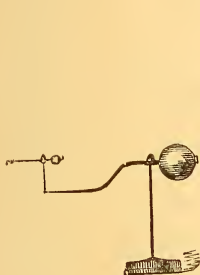
A descriptive pamphlet, with full directions for use, will be sent with each machine, and by mail, to any one who may apply for it.

No.	Price.
98. Ritchie's Holtz Machine, with four sectors, and 20 inch revolving plate (see cut upon the cover), insulated pillars.	115.00
99. Ritchie's Holtz Machine, revolving plate 16 inches diameter, with two sectors.	60.00
100. Prime Conductor, of large surface, mounted upon a glass pillar with separate base; the intensity of discharge of the Holtz machine is much increased by its use; 12.50 and	16.00



No. 101.

No.		Price.
101.	Electrical Machine. The base is a framed cross of mahogany; the plate 16 inches in diameter; the conductor is of cylindrical form, with hemispherical ends, handsomely japanned, and secured by screw mountings upon a glass pillar, with brass pedestal; the ball of the conductor has a hole drilled to insert the <i>electroscop, flier, &c.</i> ; the rubber plates are of brass, supported upon the pillar by brass springs; the machine is substantially made.	25.00
102.	Friction Cylinder; of glass, 75 cents; of vulcanite,	1.25
103.	Electroscope. Two pith balls suspended by a thread to a ball and rod, with stand; the rod is fitted to the conductor of electrical machine; the electroscop shows the presence of electricity on any body. . . .	1.00
104.	Gold Leaf Electroscope. A glass jar with base and cap, with brass stem and ball; to the stem, on the inside, are suspended two strips of gold foil; a slight electrical excitement causes the strips to repel each other. Charge the leaves by No. 102 glass rod positively; bring the electroscop near any excited body; if this is positive the leaves diverge <i>more</i> ; if negative, <i>less</i>	6.00
105.	Flier. A light wheel balanced upon a point; the arms are pointed and curved; place it upon the conductor, and when the machine is turned, the repulsion between the electricity of the points and that communicated by the points to the air, causes the wheel to revolve; in a dark room the points are luminous; 1.25 and	1.75
106.	Electrical Tellurian. Three balls upon centres in the connecting wires; it illustrates the same principal as the flier, and shows the revolution of a planet and satellite, and both around the sun. . . .	2.50
107.	Dancing Image Plates. Two metallic plates, connected by silk cords; a hook to suspend to conductor, and chain.	3.00
108.	Dancing Images. A pair of pith figures illustrating electrical attraction and repulsion.	1.00
109.	Head of Hair. A doll's head with long hair, illustrating the repulsion of substances similarly charged; each hair repels every other; the hair of a person upon the insulating stool is affected in the same manner.	2.50



No. 105.



No. 116.



No. 114.

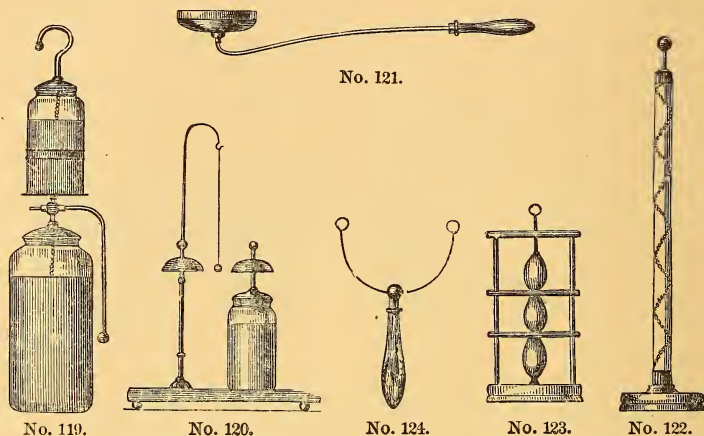


No. 103.

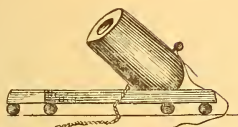


No. 104.

No.	Price.
110. Insulating Stool; 12 inches square, with cross bars and legs of solid glass firmly cemented in.	5.50
NOTE.—A board laid upon four strong glass tumblers will make a serviceable insulating stool.	
111. Electrical Bells. Two bells suspended upon a wire frame; one by brass wire, the other by silk cord; the latter has a chain to make connection with the earth; an insulated ball is alternately attracted and repelled between the bells.	3.00
112. Leyden Jar. A glass jar coated outside and inside with tin foil; a cap of wood supports a brass stem and ball, which connects with the inner coating. To charge the jar, hold it by the foil and bring the ball near the conductor; to discharge, connect by the <i>discharger</i> the outer coating with the ball; pint, 1.50; quart, 2.00; two quarts,	2.75
113. Atmospheric Jar; has a hook stem to suspend it to the conductor, to show that a jar cannot be charged without a connection by which the negative electricity can flow from the earth to the outer coating; the jar is charged very slowly, but as electricity passes freely between the atmosphere and a point, by placing the ring of points upon the jar, it is rapidly charged; quart,	3.00
114. Movable Coating Jar, consists of a jar with closely fitting metallic coatings; charge the jar as No. 112; then with a glass rod or the discharger, lift out the inner coating by its hook; the jar may now be safely taken from the outer vessel; no trace of electricity will remain in the two coatings, and if the jar is touched on both sides, only the surface touched will be discharged; now replace the parts, lifting the inner coating as before; the jar may now be discharged, showing that the electricity is accumulated on the surface of the glass, being retained by the mutual attraction of the negative and positive fluids on the opposite sides. The coatings serve only as conductors.	3.50
115. Electrometer Jar, differs from No. 112 in having a discharging rod and ball which may be adjusted near the outer foil; when the jar is charged to a sufficient intensity (greater or less in proportion to the distance of the ball), the discharge takes place; quart, 2.50; two quarts, . . .	3.25
116. Diamond Jar. The coatings on either side are small squares of foil; each perforated to show the opposite points; the discharge of the jar is very beautiful in a dark room; quart,	3.00
117. Lightning Plate, is a large plate of glass, coated on one side with foil, and on the reverse with brass filings; bring the chain from the rubbers of No. 101, or the earth chain of No. 100, to one edge of the filings, and a chain from conductor to the opposite edge; the current will pass in beautiful zigzag lines. The plate can be charged like a Leyden jar; the discharge is very brilliant.	2.00
118. Amalgam for the rubbers of the electrical machine, in box, .25 and . .	.50



- | No. | Price |
|--|--------|
| 119. Improved set of Leyden Jars; consists of a two quart <i>electrometer jar</i> , No. 115; a quart <i>atmospheric jar</i> , No. 113, and a metallic plate; remove the discharging rod and the ball from No. 115, and screw in its place the plate; remove the ring from No. 113, and set it on the plate, and thus form a <i>double jar</i> ; connect the stem of upper jar with the machine, and the foil of lower with the earth; the inside of the upper and outside of the lower will receive positive electricity; each may be discharged separately, or both together. Again connect the stem of lower with the machine; this alone is charged, (unless the ball of upper jar is put in connection with the earth;) then connect lower outer coating with ball of upper, and the lower one will be partially discharged in charging the upper one, &c. | \$6.50 |
| 120. Stand and Bells; A basement with pillar and bell, and a similar bell to screw to the stem of a Leyden jar; a little ball suspended between the bells will be alternately attracted and repelled between them, vibrating for a long time, and gradually discharging the jar. | 5.00 |
| 121. Ether Spoon; a metallic cup with a brass knob in the centre; cover the knob with ether or warm alcohol; a spark from conductor to the knob will fire the ether; a person standing upon the insulating stool, may fire it by his finger or by an icicle held in the hand. | 1.25 |
| 122. Spiral Spotted Tube and stand, 20 inches high; the electric current passes through the tube from spot to spot in beautiful scintillations; the tube may be held in the hand, or let the chain from the <i>rubbers</i> pass to the lower cap. | 4.00 |
| 123. Egg Stand; for illuminating eggs; a base with movable bars and sliding rod, for supporting eggs; the discharge of a Leyden jar beautifully illuminates the eggs, the yolk and white will be completely mingled. | 2.00 |
| 124. Discharger; a curved brass wire and balls upon a large glass handle, and a piece of chain with a hook to attach to one arm, to use when a longer reach is desired; 2.00 and | 3.50 |
| 124A. Jointed Discharger; large handle, with long curved rods, and hinged joint. | 5.25 |
| 125. Gas Pistol, for firing a mixture of hydrogen gas and air by the electric spark. | 1.00 |



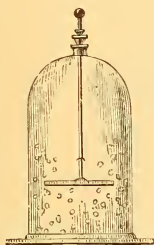
No. 126.



No. 127.



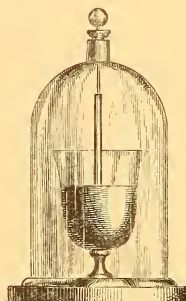
No. 128.



No. 129.



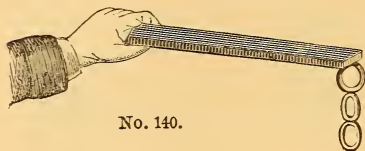
No. 132.



No. 130.

- | No. | Price. |
|---|--------|
| 126. Powder Bomb; illustrating the effect of passing the electric current through water; pour a thimble full of powder into the bomb, place a charged jar upon the chain of the bomb, thoroughly wet the cord and attach it to one arm of the discharger, bring the other arm to the ball of the jar, and the powder will be fired; if the wet string is not in the circuit the powder will not be fired. | \$2.00 |
| 127. Sportsman and Birds; put the birds on the electrometer jar; at the instant of discharge, the birds will fall. | 1.50 |
| 128. Obelisk; illustrating the lightning rod; a pyramid of several parts, resting upon a pedestal; a <i>lightning rod</i> passes down through a movable block; if this is placed so that the rod is <i>not</i> continuous, it is thrown out by the discharge of a Leyden jar, and the obelisk falls. | 5.00 |
| 129. Dancing Balls; 1 dozen pith balls in box; place the receiver, No. 45, on a metal surface; screw the plate of No. 119 on the sliding rod, and connect with machine; or hold a glass vessel so that a piece of chain from the conductor will fall inside, which will charge the surface of the glass; then throw in the balls. | .25 |
| 130. Gassiot's Cascade; a glass vase, coated on the inside with tin foil; place it under the receiver, and pass the sliding rod through a piece of glass tube down to the foil; let the rubber chain pass to the pump plate. The electrical discharge is very beautiful. | 2.50 |
| 131. Aurora Tube, (see No. 63;) exhaust the tube and pass the electrical current through it; a beautiful auroral light will fill the tube; then place the ball of the tube at different striking distances from the conductor; the electricity will flow in slender streams, <i>braiding</i> on the inner surface of the glass; the effect will be changed by gradually admitting the air to the tube. | 8.00 |
| 132. Luminous Points; two sets of points, to screw into the pump and to the sliding rod; exhaust the bell, and connect the sliding rod to the electrical machine; the discharge between the points, and the fluorescence surrounding the wires, are very beautiful. | 3.00 |

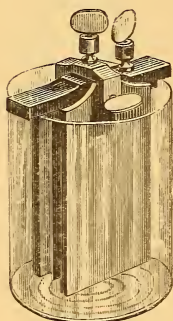
MAGNETICS.



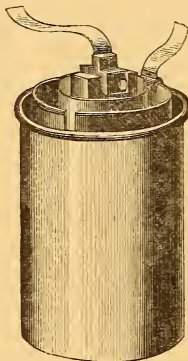
No. 140.



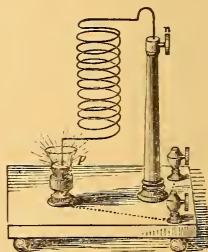
No. 141.



No. 146.



No. 147.



No. 151.

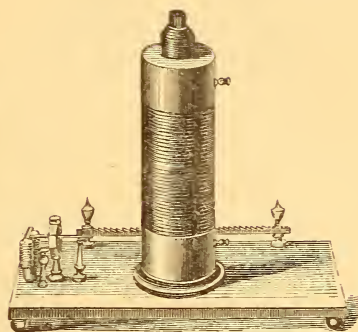
- | No. | Price |
|---|-------|
| 140. Bar Magnet; a flat steel permanent magnet, with poles marked N and S; the lines which show the resultant action of the magnetic forces are shown by laying a plate of glass over the bar, and sprinkling filings from a sieve; these lines are called magnetic curves. | 1.00 |
| 141. Horse Shoe Magnet, or U magnet, with armature of soft iron; the glass plate and filings exhibit the magnetic curves. When not in use the armature should be kept upon the poles of the magnet, 1.00 and . | 1.50 |
| 142. Magnet and Wheel Armature; the arms of the magnet are ten inches in length; a cylindrical armature, with a brass wheel. | 3.75 |
| 143. Magnetic Needle, with brass stand and point; the needle has a bell-metal centre, and is balanced to be acted upon by the earth's magnetism, as also by the attraction and repulsion of another magnet, showing that poles of opposite names attract, while those of same name repel each other. | 1.50 |
| 144. Dipping Needle, on stand. | 2.50 |
| 145. Voltaic Pair. A plate of copper and one of zinc, connected by a copper wire and glass jar. In use, the zinc must be amalgamated with mercury; use ten volumes of water to one of sulphuric acid. | 1.50 |
| 146. Smee's Battery. A glass jar with two thick plates of zinc, between which is a sheet of platinized metal. Pole cups are connected to each. Fill the jar with water, with one tenth its volume of sulphuric acid; the zinc must be kept well amalgamated with mercury. | 4.50 |
| 147. Bunsen's Battery, is composed of an outer jar nine by seven inches diameter, a zinc cylinder nine inches by five in diameter; a porous cell of unglazed earthen ware, within which is a bar of graphite. Strong copper ribbons are attached to the zinc and carbon by screw clamps. The porous cell is to be filled with nitric acid, the outer cell with a mixture of ten parts by volume of water, to one of sulphuric acid. The zinc must be kept well amalgamated. | 4.50 |



No. 152.

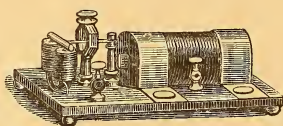


No. 154.

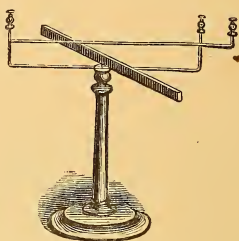


No. 162.

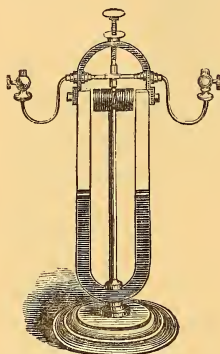
No.		Price.
148.	Thermo Plates , German silver and bismuth, for development of electricity by heat; single pair, . . . . .	.75
149.	Thermo Pile . A series of pairs of plates connect the wires to the pole cups of No. 158. Heat one end of the pile moderately, keeping the opposite end cool; the electricity excited at the soldered junctions of the two metals will cause a deflection of the needle of the galvanometer; 3.00 and	5.00
150.	Powder Cup . Brass cup, with insulated wires connected by a piece of fine platinum wire; 1.00 and	1.75
151.	Contracting Helix . Base and pillar, with adjusting screw, a spiral of copper wire, and glass mercury cup; connect the pole cups to the battery; the current through the helix will cause the spires to attract each other, lifting the point out of the mercury with a spark; the current is thus broken, the attraction ceases, and the point again dips into the mercury; the wire thus vibrates rapidly; if the battery current passes also through the coil or helix of a large electro magnet, No. 153 or No. 155, the brilliancy of the spark will be much increased.	5.50
152.	Decomposing Cell . A glass cup, with tubes and pole cups, from which platinum wires extend into the tubes; pour acidulated water into the cup; fill and invert the tubes; the action of the battery will decompose water, and the gases will be collected in the tubes. The one connected to the positive pole of the battery (the carbon) being filled with oxygen, and the other with hydrogen; 3.25 and	5.25
153.	Electro-Magnet . A bent bar of soft iron, with two helices of insulated copper wire; the iron becomes a powerful magnet when in the circuit of a battery, but ceases to be so the instant that the battery connection is broken; 2.00 and	3.00
154.	Heliacal Ring . Two semi-circular pieces of soft iron, with ring handles, and a helix of copper wire; connect the helix with the battery, and great force will be required to separate the ring.	4.25
155.	Lifting Coil . A large and thick helix and an iron rod; connect the wire to the battery, and bring the end of the iron rod below the coil, and it will be drawn in and held in suspension. 3.00 and	5.00
156.	Revolving Magnet is a steel, permanent magnet, between the poles of which is a straight electro-magnet on a spindle; the current is received through pole cups, and passes to the electro-magnet through a <i>pole changer</i> on the spindle, arranged so that at each revolution each end of the electro-magnet becomes alternately a north and south pole, and is therefore alternately attracted and repelled by the permanent magnet, producing a revolution of astonishing rapidity. . . .	8.00



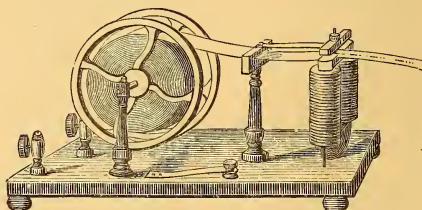
No. 163.



No. 157.

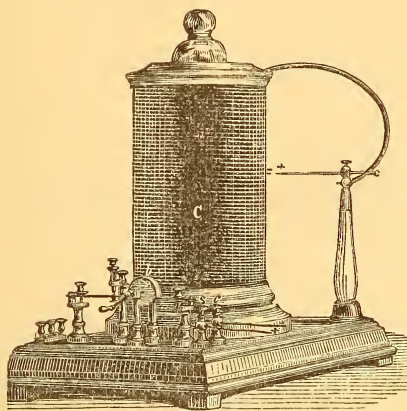


No. 156.



No. 160.

157. **Galvanometer** (Oersted's). A base and pillar supporting a wire frame, within which is placed a magnetic needle. The wire has three pole cups arranged so that the battery current may pass above, below, or around the needle, showing the influence of the current upon the needle, and measuring the force of the voltaic current by the amount of deflection of the needle; the frame must be placed north and south. 4.75
158. **Galvanometer**, compass form; a flat helix surrounds the needle, by which the current passes many times around it, increasing the power of deflection. 4.50
159. **Telegraph Model**. Upon a base is placed an electro-magnet, with its armature attached to a spring; a point upon the spring marks the paper as it is drawn out from the reel; a signal key upon a separate base, with pole cups, and a long wire to extend around the room. Connect one pole of the battery to the model, a wire from the model to the signal key, and a wire from it to the other pole of the battery. When the signal key is pressed down, the armature instantly is drawn down, marking the paper. 9.00
160. **Telegraph Model**, with the signal key on the same base. 8.00
161. **Model of Relay Magnet**. A base and an electro-magnet of fine wire, over which is a movable lever, adjustable by a spring for making and breaking a battery circuit. Use No. 146 for the relay electro-magnet, and No. 145 for telegraph model. These models will show plainly the whole operation of the *Electric Telegraph*. 7.50
162. **Separable Helices** for induction. The primary helix is supported upon a base, with a vibrating and a rasp electrotome; the core is of iron wires. The secondary helix is a separate bobbin, with pole cups. The power of the induced current is in proportion to the number of iron wires used. 18.00
163. **Double Helices**, or shocker; similar in construction to No. 162, with vibrating electrotome. The core is a bundle of iron wires, which can be drawn out, regulating the intensity of the shock; 8.50 and 7.50
164. **Handles**, with insulated wires for shocker. 2.00



No. 165.

RITCHIE'S IMPROVED INDUCTION COIL.

One of the most important instruments which have been brought out for many years, is the Induction Coil, by which all the effects of static electricity are produced from the battery. Its power is immensely greater than the electrical machine; the discharges may be made so rapidly as to appear a continuous flow, and with quantity so great that a Leyden jar can be charged and discharged as rapidly as the ear can distinguish sounds. It is not affected by the state of the atmosphere, and occupies a small space; the battery used is Bunsen's, of intensity of only two to four cells.

Previous to the invention by Ritchie of his mode of winding and insulating the helices, the longest sparks obtained in Paris were less than an inch. By his improvement, not only was the instrument rendered capable of throwing sparks of fifteen inches or more, but the quantity, or volume, is greatly increased. The mode by which this was effected was published in Silliman's Journal, and copied into the Philosophical Magazine, of London, and other scientific journals of Europe.

No.		Price.
165.	Induction Coil, mounted upon a mahogany base; the helix is covered with silk velvet, and rests upon a mahogany pedestal, and is finely finished. Capable of throwing the spark 6 inches.	337.50
166.	Induction Coil, mounted similar to No. 165, capable of giving sparks of 4 inches in length.	225.00
167.	Induction Coil, enclosed in a mahogany case of cubical form, mounted upon a base; the break-piece and pole cups for battery current, are placed on the base, the dischargers upon the top, the helices, and other portions of the instrument cannot be shown. Capable of throwing the spark four inches.	200.00
168.	Induction Coil, similar to No. 167, three inch spark.	150.00
169.	Induction Coil, similar to No. 167, two inch spark.	100.00
170.	Induction Coil, similar to No. 167, one inch spark.	60.00
171.	Geissler's Tubes. Hermetically sealed glass tubes of different forms, for the electric discharge of the Holtz Machine or Induction Coil. It would be difficult to give a description of the beauty and brilliancy of the effects produced; 2.00 to	5.00

ACOUSTICS.



RITCHIE'S IMPROVED SONOMETER.

The case is of mahogany, 40 inches in length, with sounding-board of spruce, fitted for two wires, with tension-keys and wrench, and a brass lever with two weights (1 to 4), for measuring the tension (the upper line of figures is for the smaller, and the lower line for the greater weight). Two scales divided to the diatonic scale, with letters and syllables for the *intervals* of tones and semitones, and the *ratio* of length of cord, and number of vibrations; and a scale of sixty equal parts, with the numbers for division into two, three, four, eight, &c., with movable bridges for one or both wires to rest upon.

To produce the notes of the scale, move the bridge to the letters on the scale, and sound with the bow.

For the experiment to show the law that *the rapidity of vibration is as the square root of the tension*, attach one wire to the lever, place the weight on some number and tighten the wire until the lever is brought to a level, and tune the other wire to *unison*; then change the weight to a number on the lever corresponding to a *chord*; thus, from 2 to 8 will be an *octave*; 1 to 16, two *octaves*; 4 to 9, a *fifth*.

For the experiment to show that *the rapidity of vibration is inversely as the square root of its density*, place the large wire, which is four times as heavy, on the lever, and the weight to 16; tune the other wire to *unison*, then change the large wire for one of same size as the second one, and raise the weight as before; it will sound an *octave* higher; change weight to 4 and it will give the *unison*.

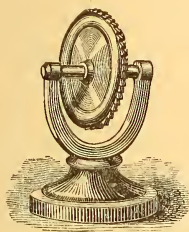
In changing considerably the weight, it will be necessary to tighten or loosen the screw to allow for the stretching of the wire.

For producing *overtones*, or *harmonics*, touch with a feather, or lightly with the finger, the wire at one of the equal divisions, and draw the bow gently across it; the wire will vibrate between the feather and fixed bridge, and also in equal divisions on the other side of the feather, but having points of rest, or *nodes*, at the divisions: e. g., touch the feather at 20, another node will be at 40; or touch at 12, other nodes will appear at 24, 36, and 48, dividing the wire into three or five equal portions, vibrating at equal times, and sounding the tone of the *second* and *fourth* harmonic of the fundamental note. A box of paper riders, blue and red, are sent to place on the wire before sounding; put some on the nodes, which will remain still, and some of another color on intermediate places, which will be instantly thrown off.

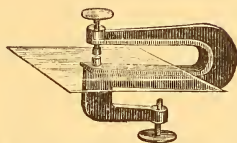
For showing *sympathetic vibrations*, tune one wire to unison or octave to the organ pipe; or sound the note with the voice, and the wire will be thrown into vibration and distinctly heard; it is essential that the unison or chord be *perfect*, or the wire will not respond. Draw the piston of the pipe while sounding it; the wire will catch and respond to the note which was for the instant of same number of vibrations.

By tuning the wires to near an unison, the effects of *interference*, or *beats*, are produced.

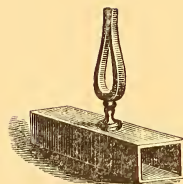
No.	Price.
180. Sonometer, with a set of wires, wrench, lever and weights.	25.00
181. Sonometer, with wires and wrench the same as above, without the lever and weights.	20.00



No. 182.



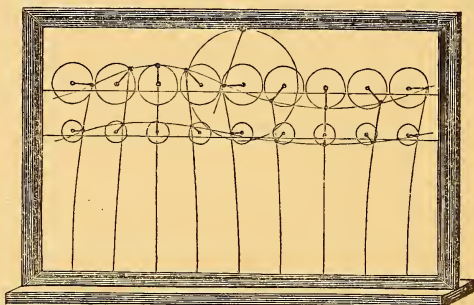
No. 183.



No. 187.

No		Price.
182.	Revolving Toothed Wheel. A heavy brass wheel supported in an iron frame and pedestal; revolve it by a cord wound around the axis, and hold a card against the teeth; a shrill musical tone will be produced, gradually falling in pitch as the speed is lessened.	7.50
183.	Iron Screw Press, for confining plates and rods for vibration, with table clamp screw.	7.50
184.	Brass Plate for vibration; hold it by the middle or other point, in the <i>Screw Press</i> ; draw the bow across the edge, and from a sand box held high above, scatter equally over the plate a small quantity of fine black writing sand, which will at once collect into fine lines, showing the <i>nodes</i> , and forming beautiful figures and curves; these are most readily obtained by touching the plate at one or two points with the finger while exciting it by the bow.	3.50
185.	Two Rods of brass for longitudinal vibration, with stand and ivory ball and clamps for holding them in No. 183. Vibrate by rubbing the rod lengthwise with a piece of resined leather; place the stand so that the ball touches the end of the rod; it will be violently repelled.	3.75
186.	Longitudinal Vibration of Rods; four wooden rods fixed at one end in a bar, to be held by No. 183. They are tuned to 1st, 3d, 5th, and 8th.	3.50
187.	Diapason, or tuning fork on sounding case. The fork and case are both tuned to the same note, $C_3 = 512$ vibrations per second; excite the fork with the bow. It can be removed from the case for experiments with the organ pipe or tubes; the reinforcement of sound by bringing it over the open end of the case, or <i>Resonant Jar</i> , is very marked.	11.00
188.	Violoncello Bow, for vibrating plates, &c.	2.00
189.	Glass Tubes of 6, 3, and $1\frac{1}{2}$ inches in length, for producing a vibration by blowing across the open ends. . . . .	.75
190.	Resonant Jar, 18 inches deep, to be partly filled with water, to be used with the tuning fork.	2.00
191.	Organ Pipe, with movable sliding piston, giving two octaves, and also showing the effect of an open and a closed pipe. The notes of the diatonic scale are marked on the piston.	4.50
192.	Organ Reed Pipe. A <i>beating</i> reed enclosed in a glass chamber, with a sliding rest, varying the vibrating length of reed.	4.75
193.	Trevelyan's Apparatus. A brass rocker with rod and ball and block of lead; heat the rocker and lay it upon the block; set it in motion and it will vibrate so rapidly as to produce a clear musical tone.	5.00
194.	Bell in Vacuum, with supporting frame and stand. The bell is sustained upon the frame by silk cords, to prevent the transmission of the vibration through the support. In use, screw the frame into the pump-plate, and ring by the <i>Sliding-rod</i>	3.25
195.	Kaleidophone; a silvered ball supported upon a slender steel wire upon a heavy iron base, showing the <i>superposition</i> of vibrations. Pluck the ball and give it a wide vibration; then strike the wire near the base, to right or left, a quick, light blow, thus giving it a vibration in another direction. By varying the blows, the reflected sunlight from the ball will give most beautiful curves and figures.	2.50
196.	Jet for singing flame to attach to <i>Hydrogen Generator</i>	1.00

UNDULATIONS.



Prof. Lyman's Wave Apparatus,—exhibiting not only the surface contour, but also the motions taking place in the whole mass of a liquid.

In front of a plane surface are two series of revolving cranks, the length of the lower ones being half that of the upper. Two elastic wires connect the crank-pins of each series; upright wires also connect each pair of cranks, and pass down through a plate into the base. The cranks all revolve synchronously; they thus keep their relative position, and come to any particular position successively, each in its turn.

The circles represent the orbits of as many liquid particles. The transverse wires represent continuous lines of particles, which at rest would be horizontal, and thus coincide with the lines drawn on the background, the upper being the surface line, the lower a line of particles one ninth of a wave's length below. The upright wires represent lines of particles which at rest would be vertical. Every point in these moving lines describes its own distinct orbit. The spaces between the wires show the varying distortions of sections of water originally rectangular.

The circumference of the larger circle equals a wave's length; its radius, the height of a revolving pendulum keeping time with the wave. If this circle be rolled under a horizontal line, a point half the wave's height distant from its centre will trace the wave profile; the rolling circle for all profiles down to still water is the same. The sharper curvature of the crests than of the troughs, and its cause, are both made obvious. The wire pendulum represents the resultant of the weight and centrifugal force of a particle, and is normal to the wave surface.

Since the motions are the same essentially as in nature, the various geometrical and dynamical points of the theory of waves are strikingly exhibited. A full description, with statement of the facts and principles illustrated, will be sent with each instrument. It can also be had on application.

NUMBER

PRICE

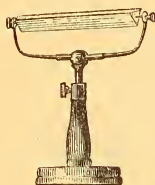
197. Lyman's Wave Apparatus Frame, 26 inches long, with nine pairs of cranks,

35.00

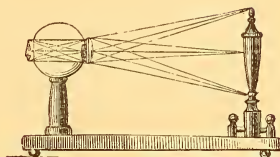
OPTICS.



No. 212.

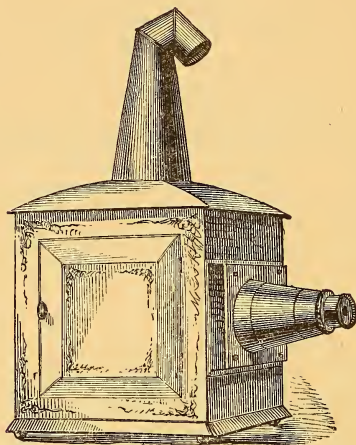


No. 202.



No. 213.

No.	Price.
201. Prism, finely polished; three inch, 1.00; four inch 1.50; five inch, . . .	2.00
202. Mounted Prism, suspended by points in frame, with movable joint and stand, so that it may be adjusted to a beam of light.	6.00
203. Achromatic Prism. A pair of flint and crown glass.	7.50
204. Prismatic Lens, or multiplying glass, mounted in tube; the lens is ground with a great number of plane faces. . . . .	.75
205. Neutralizing Lenses. Pair of double convex and concave lenses. . .	3.00
206. Neutralizing Lenses. Set of four double and plano-convex and concave lenses.	6.00
207. Condensing Lens, mounted on elevating stand.	10.00
208. Convex and Concave Mirrors. Ground and polished silvered lenses, in frame; four inch, 4.50; six inch,	5.50
209. Cylindrical Mirrors, similar to No. 208; four inch, 3.00; six inch, . .	4.00
210. Multiplying Mirrors. Four inch, 3.00; six inch,	4.00
211. Mounted Mirror, on stand, to use with a beam of light through a shutter, &c.	4.25
212. Model of the Eye, dissected, showing the coats, retina, iris, crystalline lens, &c., with stand.	8.00
213. Illustration of long, short, and perfect sight, the projection and inversion of the image on the retina, and march of the rays through the crystalline lens.	7.00
214. Revolving Disk Apparatus. Mahogany base, metal frame, with pulleys and crank; a shaft, with screws for confining disks.	9.00
215. Set of Disks. Circles of cardboard and paper of brilliant colors, including Newton's Disk and forms to show the gradual blending of one color into another. One set of paper is cut in such manner that they can be arranged so that any combination of the colors can be made in the circle.	1.75
216. Newton's Disk. A card to revolve by the twisting of a double cord between the hands. . . . .	.75
217. Newton's Rings Apparatus. A lens and plate of glass mounted in brass cell with screws.	6.50
218. Zoetrope. A revolving cylinder with a series of open slits, to produce the effect of motion by successive pictures seen through the slits. . .	5.00
219. Stereoscope, Dr. Holmes' form; the eyes are shaded, but the picture is placed on a sliding bar in open light; 2.00 and	3.00
220. Photographic Pictures. Buildings, landscapes, figures, statues, &c., plain and colored; from .15 to . . . . .	.50
221. Compound Microscope, with adjustable draw tube, double system of objectives, in mahogany box.	4.50
222. Compound Microscope, adjustable tube, with condensing lens, and triple system of objectives, in mahogany box.	8.00



No. 223.

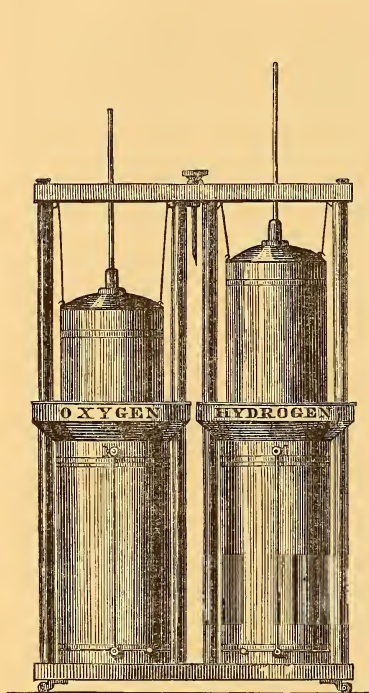
- | No. | | Price. |
|------|---|--------|
| 223. | Magic Lantern , of improved construction, made of heavy tin, handsomely japanned; the condensers are of superior quality, four inches in diameter, mounted in brass cell; the magnifiers are a combination of meniscus and plano lenses, a late improvement, by which the spherical aberration is well corrected, and all parts of the picture brought into focus, and distinctly thrown upon the screen; these are mounted in a brass tube with a diaphragm; an improved solar or petroleum lamp, with silver-plated reflector, and spring holder for sliders. | 40.00 |
| 224. | Ritchie's Improved Porte Lumière , for reflecting the rays of the sun through the shutter of a darkened room; a mirror of 13 by 4 inches is supported upon a brass revolving plate in such a manner that it can be placed in any position, and have the motions easily given to reflect the solar rays horizontally through the opening. It is attached to a brass frame and plate, to be screwed upon the outside of the shutter. On the inner side is a tube for the lenses, with diaphragms of different apertures; it can be used in a window of East, South, or West aspect; the importance and advantages of having a room thus fitted can hardly be over-estimated for experiments and illustrations, both in <i>heat</i> and in <i>light</i> | 35.00 |
| 225. | Attachment for Pictures , including condensing lens mounted in cell, magnifying lenses mounted in tube similar to those in No. 223, with supports and adjustments for lenses, and for pictures.
The effects produced by solar light are far superior to those with artificial light. | 27.50 |
| 226. | Achromatic Magnifying Lenses , for No. 223, or No. 224, additional price, | 10.00 |

We keep a selection of sliders, American and foreign views, &c., made by W. Langenheim, of Philadelphia, and others, but cannot give space to transfer their catalogues to our pages. We confine our assortment of pictures principally to scientific subjects, of a quality we think unequalled; a condensed list is given on next page.

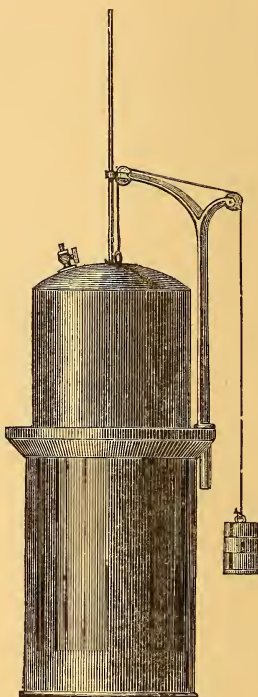
The following is a catalogue of pictures which are made especially for us by Dr. D. H. Briggs; the subjects are selected from the best authorities, photographed, and colored in the highest style of the art.

NUMBER	PRICE
237. Astronomy , set of thirty pictures, in 3 inch single sliders, in box, including diagrams and telescopic views by Naysmith, Lord Rosse, De la Rue, and Lockyer, viz. :	45.00
Systems of Ptolemy and Tycho Brahe. Copernician system. Spot on the sun, as seen by a powerful telescope (Naysmith). Phases and apparent dimensions of Venus. Inclinations of the axes of the planets. Diagram illustrating refraction. Parallels, meridians, and zones. True and mean place of a planet in its orbit. Seasons, length of days, etc. Signs of the zodiac. Telescopic views of the moon. Cause of the moon's phases. Mountains on the moon (Naysmith and De la Rue). Inclination of the moon's orbit. Diagram to explain eclipses. Total eclipse of the sun (De la Rue). Illustration of the tides. Telescopic views of Mars (Lockyer), of Jupiter (De la Rue), and of Saturn. Comet of 1811. Comparative size of the sun and planets. North circumpolar stars. Orion and adjacent constellations. Star cluster, or resolvable nebulae. Dumb-bell nebulae in Leo (Lord Rosse). Lord Rosse's telescope.	
238. Astronomy ; set of twenty 3 inch pictures from the above,	30.00
239. Anatomy and Physiology ; set of twenty 3 inch pictures,	30.00
Human Skeleton. Skull. Section of the spine, etc. Teeth, and structure of the same. Muscles, front view. Muscles, back view. Muscles of the head, neck, and face. General view of digestive organs in place. The digestive organs. The stomach, liver, and pancreas. Thoracic duct. Heart and lungs. Diagram of circulation. Skin. Brain and spinal cord. General view of the nerves. Fifth pair of nerves. Facial nerves. Diagram of the eye. Anatomy of the ear.	30.00
240. Geology ; set of twenty 3 inch pictures, including geological record, ideal section of the earth's crust, thickness of the earth's crust, section of volcano in action, Fingal's cave, grotto of Antiparos, glacier of Mount Rose, glacier tables, corals and coral islands, trilobites, ammonites, rain drop marks, pterichthys, coelocostes, cephalaspis, fossil fern, a thrust in a coal mine, ichthyosaurus, plesiosaurus, pterodactyle, fossil foot marks, the mammoth restored,	30.00
241. Botany ; set of twenty 3 inch pictures,	30.00
242. Natural History ; illustrations of various classes of mammalia, birds, reptiles, fishes, insects, crustacea, annelida, mollusca, and radiata, each	2.75
243. Historical Subjects ; copies of celebrated pictures; manners and customs of the East; animals and plants mentioned in the Scriptures, each	2.75
244. Numerous illustrations of Bible lands, including views in Palestine, Egypt, Assyria, Petraea, &c. <i>Floral</i> subjects in variety. Prices of the above in 3 inch sliders, each	2.75
245. Statuary , many of the most noted of antique and modern art, three inches diameter, with black background, 1.50; with blue, crimson, or gold background, each	2.00
246. Newton's Disc ; revolving slider with prismatic colors for recomposing white light,	7.50
247. Chromatropes ; a variety of beautiful chromatropes, unsurpassed in brilliancy and colors,	5.00

CHEMISTRY.

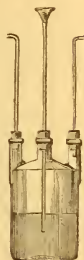


No. 241.



No. 242.

No		Price.
241.	Gasometers. A pair, of copper, with side tubes enclosing balance weights, mounted on base with casters; brass tubes, with stop-cocks; cylindrical pressure weights; the bells $7\frac{1}{2}$ inches diameter by 17 inches in height.	70.00
242:	Gasometer. Cylindrical bell and cistern, made of thick, galvanized, japanned metal, and painted with a preparation nearly insoluble. A movable metal crane, with pulleys and balance weight made in sections; by removing one or more a corresponding pressure is exerted on the gas; the bell is 16 inches in diameter, and 26 inches high. Capacity 22 gallons, and is warranted to be strong and durable.	35.00
243.	Gasometer. Similar to No. 242; the bell is 11 inches diameter, and 24 inches high.	30.00
244.	Pneumatic Trough, of stout, galvanized iron; 20 inches long by 15 wide, and 12 inches deep, with movable shelf; japanned.	7.50
245.	Gas Bag, of square form, of vulcanized rubber-cloth, with socket, 18 by 20 inches; capacity, 15 gallons.	8.25
246.	Gas Bag, with socket, 24 by 30 inches; capacity, 35 gallons.	12.00
247.	Gas Bag, with socket, 30 by 40 inches; capacity, 55 gallons.	15.00
248.	Gas Bags of rubber, oval, 1 to 4 gals., with sockets, 2.50 to	5.25
249.	Hydrogen Generator of glass, with inverted bell and stop-cock, a copper basket for granulated zinc, and a solid ball of zinc; the cover is held by screws beneath a flange.	9.00



No. 315.



No. 275.



No. 249.

No.		Price.
250.	Gas Generator of glass, with inverted bell, basket for zinc; the bell is attached to a rubber tube, with nipper tap.	5.00
251.	Oxygen Flask of copper, thick bottom, screw cap; one quart,	5.50
252.	Oxygen Flask, similar to above with gallows screw cap.	8.00
253.	Bottle Generator, pint, with rubber cork and tubes.	1.00
254.	Nitric Oxide Bell and Jar; the jar is ten inches by four in diameter, the bell one half its capacity; both ground to fit a glass plate. . . .	2.50
255.	Oxy-Hydrogen Concentric Jet, with adjustable lime-holder, and gallows screw connections.	18.00
256.	Rubber Hose to connect oxy-hydrogen jet to Gasometers or bags, each six feet long, with brass sockets.	6.00
257.	Platinum Sponge, jet and holder to attach to No. 249.	1.75
258.	Bottles and Tube for illustrating the diffusion of gases; two bottles with rubber corks, connected by a glass tube.	1.00
259.	Mercury. The price is variable; our charge will depend on its commercial value. At present it is, per pound,	1.00
260.	U Tube, with one end closed, tubulated near the bend, to which is attached a piece of rubber tube with a nipper tap.	2.50
261.	Glass Cylinder, with foot, 7 by 1½ inches, ground mouth and plate. .	1.50
262.	Glass Cylinder, with foot, 5 by 1 inch diameter, and plate.	1.00
263.	Flat Glass Dish, 9 inches diameter, 2 inches deep.	1.50
264.	Cylindrical Jar, with ground edge; two quarts.	1.50
265.	Endosmeter, or osmose apparatus; a glass bell over which to tie a membrane, with glass tube and rubber cork.	1.75
266.	Porous Cup and Tube, for osmose of gases.	1.00
267.	Chlorine Tube, of glass, fifteen inches long, closed at one end; an interior jet tube with rubber to connect to a funnel.	1.50
268.	Eudometer, a U tube closed at one end, with platinum electrodes for exploding gases; plain, 3.00; graduated,	4.00
269.	Rubber Corks, assorted to one inch diameter; one dozen in box. . .	.35
270.	Bunsen's Burner, with stand.	1.50
271.	Evaporating Dishes, porcelain, 33, 40, 50, and . . . . .	.60
272.	Chalk Cup, 2 inches by 1½ diameter. . . . .	.50
273.	Nipper Tap, or spring stopcock for closing tubes; 35 cents and . . .	.50
274.	Wash Bottle, with tubes and rubber stopper.	1.75
275.	Lamp Stand, with three bows and binding screws, 2.00; four bows, .	2.25
276.	Iron Chimney for lamp. . . . .	.35
277.	Rubber Tubing, of calibre from eighth to half inch; per foot, 12 to .	.35
278.	Cork Borers; set of three, 2 25; set of six,	3.25
279.	Hydrogen Balloons, of goldbeater's skin, 3.00 to	6.00
280.	Pendent Spoon and Rod, copper, 50 cents; platinum,	1.50
281.	Retort Holder, base and pillar, with two pair of spring and screw jaws for holding tubes, retorts, &c.	3.50

No.		Price.
282.	Evaporating Dishes, porcelain, nests of six.	2.00
283.	Hessian Crucibles, in nest, . . . . .	.25
284.	Porcelain Mortar and Pestle; 1.00 to	3.00
285.	Agate Mortar and Pestle; 1.50 to	7.00
286.	Sheet Rubber, piece, for square foot, . . . . .	.50
287.	Dissolved Rubber, in tin boxes, . . . . .	.75
288.	Crucible Tongs, of iron; 1.00 and	2.50
289.	Sefstroem's Retort Holder, wood clamps, mounted on iron stand. . .	5.00
290.	Nipper Tube Holder, wood screw clamps with cork jaws.	3.00
291.	Copper Alcohol Lamp, with five wicks.	2.25
292.	Spirit Lamp, with ground cap.	1.00
293.	Plain Mouth Blowpipe, of brass. . . . .	.50
294.	Blowpipe, with condensing bulb.	1.50
295.	Test Tubes, with mahogany stands; 12 tubes, 2.00 and	3.25
296.	Mouthpiece for inhaling gas.	2.00
297.	Filtering Paper, in packages; 75 cents to	1.00

Chemical Glass Ware.

298.	Receivers of different forms, see <i>Pneumatics</i> .	
299.	Hydrometer Jar, with foot and lip.	1.25
300.	Bolt Heads, or Matrass, pint, fifty cents; quart . . . . .	.75
301.	Funnels, gill, 25 cents; half pint, 35 cents; pint, 45 cents; quart, . . . .	.60
302.	Graduated Ounce Measure; 2 oz. 65 cents; 4 oz. 75 cents; 8 oz. . . .	1.00
303.	Stirring Rods, set of six, . . . . .	.50
304.	Safety Tubes; straight, 25; bent with bulbs, . . . . .	.60
305.	Pipette, or Dropping Tube; 25 and . . . . .	.50
306.	Two Bulbs and Tube, Brand's, for condensation, . . . . .	.75
307.	Glass Chemical Tubes; per pound, 75 cents to	1.25
308.	Glass Barometer Tubes, small and large, per pound,	1.50
309.	Rupert's Drops, unannealed glass, per dozen,	1.00
310.	Bologna Vials, unannealed; per dozen,	2.25

Bohemian Hard Glass without Lead.

311.	Retorts; half pint, 40 cents; pint, 55 cents; quart, . . . . .	.65
312.	Retorts; tubulated, 3 oz., 40 cents; 4 oz., 50 cents; half pint, 60 cents; pint, 76 cents; quart,	1.00
313.	Flasks, with rim necks for corks, uniformly thin throughout; 4 ounce, 30 cents; half pint, 35 cents; pint, 50 cents; quart, . . . . .	.65
314.	Digesting Flasks, with flat bottoms and rim neck; 2 oz., 30 cents; 4 oz. 30 cents; half pint, 35 cents; pint, 50 cents; quart, . . . . .	.65
315.	Woulfe's Bottles, with three necks; pints, 1.25; quarts,	1.50
316.	Globe Receivers, tubulated; half pint, 50 cent; pint, 65 cents; quart, . .	.75
317.	Beaker Glasses, in nest; 1.25 to	3.50
318.	Test Tubes, with rim and lip; per dozen, 50 cents to	1.25

Globes.—Terrestrial and celestial globes, made by G. Joslin, of Boston (late Loring). These globes are considered the most accurate of any now made; the engravings have been corrected to late discoveries and geographical changes, and are of superior construction.

No.	Price.
320. Globes on bronzed pedestal stand, with casters; this style of mounting has the advantage of great stability, convenience, and beauty of design; 12 inch, 37.50; per pair,	75.00
321. Globes, 12 inch, on full frame stand, each 22.00; per pair,	44.00
322. Globes, 10 inch diameter, frame stand, each 17.00; per pair,	34.00
323. Globes, 10 inch, semi-stand, each 10.00; per pair,	20.00
324. Globes, 6 inch, semi-stand, each 5.00; per pair,	10.00
325. Joslin's Solar Telluric Globe.	15.00
326. Improved Seasons Machine, giving the motions of the earth around the sun, the inclination and parallelism of the earth's axis, the causes of the seasons, the revolution of the moon around the earth, the moon's nodes, the revolution of the sun and earth on their axes; five inch sun, three inch terrestrial globe for the earth.	14.00
327. Whital's Movable Planisphere of the Heavens, with the Constellations handsomely colored. The starry heavens are delineated on a movable planisphere, exhibiting the position of the constellations in the firmament, as seen in the United States every five minutes during the year. The right ascension and declination of the sun, moon, stars, and planets; equation of time (sun fast or slow); harvest moon; sun and moon running high or low; the milky way, as it changes its course every hour; change of seasons; variation of the magnetic needle, &c., can be readily explained by this valuable substitute for a celestial globe, with full explanations for the use of the planisphere, and of the problems which may be solved. Plain, £.50; colored,	3.00
328. Rain Gauge, of improved form; copper cylinder with exterior glass tube and graduated scale.	14.00
329. Geometrical Solids. Set of thirteen, including three and six-sided prisms, cylinders, cone, pyramid, frustums of cone and pyramid, sphere, hemisphere, oblate and prolate spheroids, neatly made in fine wood, and in box.	2.00
330. Models of Crystals. Thirteen pieces, giving the fundamental forms, according to Dana, in large size.	3.25
331. Cube Root Solids, illustrating the extraction of square and cube roots, of mahogany, in box.	1.25
332. Set of 64 inch Cubes, for same illustrations in box.	1.75
333. Set of Solids, illustrating the mensuration of solids; ten cubes, rectangular and oblique prisms, papered, with lines.	1.50
334. Dissected Cone, illustrating conic sections; viz., the circle, ellipse, parabola and hyperbola, made in an improved manner, so that the divisions fit accurately, and outline of cone is unbroken; the parts are connected by dowels.	3.00
335. Plotting Instruments, including a compass with shifting leg, ink and crayon points, a pair of dividers, and line pen, in box.	4.50

CATALOGUE.

\$200.00

SET No. 2.

Arranged for and adopted by the City School Committee, for the
BOSTON GRAMMAR SCHOOLS.

Laws of Matter.		No.		Price.
No.		No.		
2. Lead Hemisphere.	1.00	120. Stand and Bells.		5.00
3. Inertia Apparatus.	1.75	121. Ether Spoon.		1.25
5. Capillary Tubes.	1.00	122. Spiral Tube.		4.00
6. Capillary Plates.	1.50	124. Discharger.		2.00
8. Collision Balls.	3.50	125. Gas Pistol.		1.00
9. Centre of Gravity.	10.00	126. Powder Bomb.		2.00
14. Mechanical Powers.	33.00	129. Dancing Balls. . . . .		.50
18. Central Forces.	3.75			
19B. Illustration of the Pendulum.	3.50			
Hydrostatics.		Magnetics.		
20. Equilibrium Tubes.	3.50	140. Bar Magnet.		1.00
22. Upward Pressure of Liquids.	3.00	142. U Magnet, and Wheel.		3.75
25. Tantalus Cup.	2.00	143. Needle and Stand.		1.50
27. Model of Pump.	9.00	147. Bunsen's Battery.		4.50
29. Archimedes Principle.	2.50	150. Powder Cup.		1.75
Pneumatics.		153. Electro Magnet.		2.00
40. Air Pump.	25.00	154. Helical Ring.		4.25
44. Receiver, one quart.	1.00	156. Revolving Magnet.		8.00
45. Sliding Rod Receiver.	5.00	157. Galvanometer.		4.75
47. Hand Glass.	1.25	159. Telegraph Model.		9.00
48. Condenser.	9.50	163. Double Helices.		7.50
49. Condensing Chamber.	8.50	164. Handles and Wires.		2.00
51. Expansion Bolt-head. . . . .	.75	Acoustics.		
53. Bacchus Illustration.	2.75	180. Sonometer.		25.00
54. Magdeburg Hemispheres.	7.50	183. Screw Press.		7.50
56. Weight and Buoyancy.	7.50	184. Vibrating Plate.		3.50
59. Barometer Apparatus.	6.00	188. Violoncello Bow.		2.00
63. Guinea and Feather Tube.	8.00	191. Organ Pipe.		4.50
64. Air Gun.	1.25	194. Bell in Vacuum.		3.25
66. Cylinder and Weight. . . . .	.25	Optics.		
68. Washers and Oil. . . . .	.50	201. Prism.		1.50
Heat.		204. Multiplying Lens. . . . .		.75
71. Pulse Glass.	1.00	205. Convex and Concave Lenses.		3.00
72. Ring and Ball.	2.25	208. Convex and Concave Mirrors.		4.50
74. Compound Bar.	1.25	212. Model of the Eye.		8.00
75. Fire Syringe.	3.00	216. Newton's Disk. . . . .		.75
76. Reflectors.	9.00	Geometry.		
78. Wire Gauze. . . . .	.75	329. Set of Solids.		2.00
82. Ventilation.	3.50	330. Crystal Models.		3.25
86. Conductometer.	4.50	332. Cube Root Solids.		1.75
292. Spirit Lamp.	1.00	Recapitulation.		
Electricity.		MECHANICS.		59.00
99. Holtz Machine.	60.00	HYDROSTATICS.		20.00
100. Prime Conductor.	12.50	PNEUMATICS.		84.75
102. Friction Cylinder. . . . .	.75	HEAT.		26.25
103. Electro-scope.	1.00	ELECTRICITY.		108.75
105. Flier.	1.25	MAGNETISM.		50.00
110. Insulating Stool.	5.50	ACOUSTICS.		45.75
114. Movable Coating Jar.	3.50	OPTICS.		18.50
117. Lightning Plate.	2.00	GEOMETRY.		7.00
119. Improved set of Jars.	6.50			

\$428.00

SET No. 3.

The following Set has been prepared with the assistance of the authors, for the **Hand Book of Natural Philosophy**, of the Cambridge Course of Physics.

No.	Cohesion.	Price.	No.	Price.
73.	Bar and Gauge.	2.25	190.	Resonant Jar. 2.00
313.	Two Flasks and Tubes.	1.25	191.	Organ Pipe with Sliding Piston. 4.50
2.	Lead Hemispheres.	1.00	Light.	
283.	Crucibles. . . . .	.25	201.	Prism. 2.00
309.	Six Rupert's Drops. . . . .	.50	214.	Revolving Disk Apparatus. . . 9.00
264.	Two quart Cylindrical Jar.	1.50	215.	Set of Disks. 1.75
305.	Dropping tube. . . . .	.50	217.	Newton's Rings. 6.50
318.	Six Test-tubes. . . . .	.50	218.	Convex and Concave Mirrors. . 4.50
259.	Mercury.	5.00	206.	Neutralizing Lenses. 3.00
Adhesion.			Heat.	
23.	Glass Disk, with Cord.	1.50	85.	Differential Thermometer. . . . 3.50
301.	Two Funnels, and Filters.	1.00	86.	Conductometer. 4.50
5.	Set of Capillary Tubes.	1.00	79.	Specific Heat. 1.75
301.	Glass Funnel Tube. . . . .	.25	80.	Pair of Plates. 1.50
265.	Apparatus for Osmose.	1.75	74.	Compound Bar. 1.25
258.	Bottles and Tube.	1.00	82.	Convection of Gases. 3.50
266.	Cup and Tube.	1.00	89.	Mason's Hygrometer. 4.00
Mechanics.			75.	Fire Syringe and Tinder. . . . 3.00
10.	Centre of Gravity.	5.00	292.	Spirit Lamp. 1.00
20.	Liquid Equilibrium Tubes.	3.50	Electricity.	
34.	Hydrostatic Press.	9.00	140.	Bar Magnet. 1.00
31.	Hydrometer.	1.25	141.	U Magnet. 1.00
29.	Cylinder and Cup.	2.50	145.	Voltaic Pair. 1.50
40.	Ritchie's School Air Pump	25.00	147.	Bunsen's Cell. 4.50
45.	Sliding-rod Receiver.	5.00	143.	Magnetic Needle. 1.50
44.	Plain Quart Receiver.	1.00	157.	Galvanometer. 4.75
56.	Weight and Buoyancy.	7.50	153.	Electro-Magnet. 3.00
54.	Magdeburg Hemispheres.	7.50	155.	Lifting Coil. 3.00
47.	Hand Glass.	1.25	156.	Revolving Magnet. 8.00
55.	Rubber Bag and Cap.	2.25	160.	Model of Telegraph. 8.00
58.	Barometer Tube.	1.50	152.	Decomposing Cell. 3.25
27.	Model of Lifting Pump.	9.00	163.	Vibrating Shocker. 7.50
24.	Siphon. . . . .	.50	150.	Powder Cup. 1.00
25.	Tantalus Cup.	2.00	102.	Vulcanite Cylinder. 1.25
63.	Guinea and Feather Tube.	8.00	101.	Electrical Machine. 25.00
19.	Illustration of Pendulum.	3.50	112.	Leyden Jar. 2.00
18.	Central Forces.	3.75	124.	Discharger. 2.00
12.	Models of Levers.	5.50	104.	Electric Wheel. 1.25
11.	Models of Pulleys.	20.00	120.	Stand and Bells. 5.00
Sound.			Recapitulation.	
194.	Bell for Vacuum.	3.25	COHESION.	12.75
182.	Revolving Toothed Wheel.	7.50	ADHESION.	7.50
187.	Tuning Fork and Case.	11.00	MECHANICS.	124.50
100.	Sonometer, with Wires.	25.00	SOUND.	70.00
188.	Violoncello Bow.	2.00	LIGHT.	26.75
184.	Vibrating Plate.	3.50	HEAT.	24.00
185.	Brass Rods and Ivory Ball.	3.75	ELECTRICITY.	84.50
183.	Iron Screw Press.	7.50		

\$350.00

SET No. 4.

Additional to the Set No. 3, specially adapted to the Cambridge Course of Physics.

Cohesion.	
No.	Price.
271. Two Evaporating Dishes. . . .	1.00
260. U Tube, with Nipper Tap. . . .	2.50
281. Retort and Tube Holder. . . .	3.60
259. Mercury.	6.00

Adhesion.	
263. Glass Dish.	1.50
6. Pair of Capillary Plates. . . .	1.50
261. Cylindrical Jar.	1.50
262. Cylindrical Jar.	1.00
258. Bottles with Tubes.	3.50
48. Condenser.	9.00
49. Condensing Chamber.	6.50
13. Screw, Wedge, Inclined Plane. .	7.50
64. Air Gun.	1.25
65. Revolving Jet.	2.50
36. Barker's Mill.	1.25
77. Wollaston's Engine.	5.50

Sound.	
186. Vibrating Rods on Bar.	3.50
189. Three Glass Tubes. . . . .	.75
192. Organ Reed Pipe.	4.75
196. Jet for Singing Flame.	1.00

Light.	
207. Condensing Lens, Mounted. . .	10.00
202. Mounted Prism, dif. over 201. .	4.00
203. Achromatic Prism.	7.50
218. Zoetrope.	5.00
211. Mounted Mirror.	4.25

No.	Price
219. Stereoscope, with 12 Diagrams. .	4.50
81. Iodine Cell.	5.00
90. Hygrodeik, difference over 89. .	11.00
76. Pair of Reflectors, and Ball. . .	12.50

Electricity.

144. Dipping Needle.	2.50
154. Helix and Ring.	4.25
161. Model of Relay Magnet.	9.50
149. Thermo-Electric Series.	3.00
162. Helices, dif. over 163.	10.50
99. Holtz Machine, dif. No. 20. . . .	35.00
100. Insulated Conductor.	12.50
108. Gold Leaf Electroscope.	6.00
116. Diamond Jar.	3.50
122. Spotted Tube.	4.00
130. Gassiot's Cascade.	2.50
171. Geissler's Tubes.	10.00

Recapitulation.

Including Set No. 3.

COHESION.	25.75
ADHESION.	13.00
MECHANICS.	175.00
SOUND.	80.00
LIGHT.	66.00
HEAT.	52.60
ELECTRICITY.	187.75
	<hr/>
	\$600.00

SET No. 5.

Designed for the Hand Book of Chemistry, Cambridge Course of Physics.

261. Cylinder and Plate.	1.50
262. Cylinders and Plate.	1.00
264. Two Jars, 2 qts., ground edge. .	3.00
273. Two Nipper Taps. . . . .	.70
248. Gas Bag, two gallons.	3.00
253. Bottle Generator.	1.00
313. Three half pint Flasks.	1.05
275. Lamp Stand.	2.00
292. Spirit Lamp.	1.00
281. Retort Holder.	3.50
267. Chlorine Tube.	1.50

317. Two Beakers. . . . .	.50
271. Two Evaporating Dishes. . . .	.50
268. Eudiometer.	3.00
272. Chalk Cup. . . . .	.50
274. Wash Bottle.	1.75
254. Nitric Oxide Bell.	2.50
311. Half Pint Retort. . . . .	.40
318. Test Tubes, one dozen. . . . .	.50
307. Glass Tubing, half pound. . . .	.50
277. Rubber Tube, three feet. . . .	.60
	<hr/>
	\$30.00

SET No. 6.

Laws of Matter.			
No.	Price	No.	Price.
2. Lead Hemispheres.	1.00	78. Wire Gauze. . . . .	.75
5. Capillary Tubes.	1.00	79. Specific Heat.	1.75
6. Capillary Plates.	1.50	80. Plates for Radiation.	1.50
8. Collision Balls.	3.50	82. Principle of Ventilation.	3.50
9. Centre of Gravity.	10.00	84. Thermometer.	1.25
14. Mechanical Powers.	33.00	85. Differential Thermometer.	3.50
18. Central Forces.	3.75	86. Conductometer.	4.50
19 A. Parallelogram of Forces.	7.50	87. Eolipile.	3.50
19 B. Pendulum.	3.50	88. Pyrometer.	7.50
330. Crystal Models.	3.25	89. Psychrometer.	4.00
		292. Spirit Lamp.	1.00
Hydrostatics.		Electricity.	
20. Equilibrium Tubes.	3.50	99. Holtz Machine.	60.00
22. Cylinder and Plate.	3.00	100. Prime Conductor.	12.50
23. Liquid Adhesion.	1.50	102. Friction Cylinder.	1.25
24. Siphon. . . . .	.50	103. Electroscope.	1.00
25. Tantalus Cup.	2.00	105. Flier.	1.75
28. Set of Pumps.	22.50	108. Gold Leaf Electroscope.	6.00
29. Archimedes Principle.	2.50	110. Insulating Stool.	5.50
31. Hydrometer.	1.25	114. Movable Coating Jar.	3.50
299. Hydrometer Jar.	1.25	116. Diamond Jar.	3.00
34. Hydrostatic Press.	9.00	117. Lightning Plate.	2.00
36. Barker's Mill.	1.25	119. Set of Jars.	6.50
		120. Stand and Bells.	5.00
Pneumatics.		121. Ether Spoon.	1.25
41. Air Pump.	100.00	122. Spiral Tube.	4.00
44. Receiver.	1.00	124A. Discharger.	5.25
45. Receiver.	5.00	126. Powder Bomb.	2.00
46. Cylindrical Jar.	1.50	128. Obelisk.	5.00
47. Hand Glass.	1.25	129. Dancing Balls, two dozen. . . . .	.50
48. Condenser.	9.50	130. Gassiot's Cascade.	2.50
49. Condensing Chamber.	8.50	132. Luminous Points.	3.00
52. Freezing Apparatus.	4.00		
54. Magdeburg Hemispheres.	7.50	Magnetics	
55. Rubber Bag.	2.25	140. Bar Magnet.	1.00
56. Weight and Buoyancy.	7.50	142. U Magnet and Wheel.	3.75
59. Barometer Apparatus.	6.00	143. Needle and Stand.	1.50
259. Mercury.	2.00	145. Voltaic Pair.	1.50
60. Fountain.	6.50	146. Smee's Battery.	4.50
63. Guinea and Feather Tube.	8.00	149. Thermo Pile.	5.00
64. Air Gun.	1.25	150. Powder Cup.	1.75
65. Revolving Jet.	2.25	151. Contracting Helix.	5.50
66. Wood Cylinder. . . . .	.25	152. Decomposing Cell.	5.25
68. Washers. . . . .	.25	153. Electro Magnet.	3.00
69. Oil. . . . .	.25	154. Helical Ring.	4.25
		155. Lifting Coil.	5.00
Heat.		156. Revolving Magnet.	8.00
71. Pulse Glass.	1.00	158. Galvanometer.	4.50
73. Bar and Gauge.	2.25	159. Telegraph Model.	9.00
74. Compound Bar.	2.25	161. Relay Model.	7.50
75. Fire Syringe.	3.00	162. Separable Helices.	18.00
76. Reflectors.	12.50	164. Handles and Wires.	2.00
77. Wollaston's Engine.	5.50	171. Geissler's Tubes.	12.50

[illegible]

The above sets have been compiled with the view to combine instruments for the illustration of as many and as varied principles as the limits of the amount of each will permit, to avoid duplications, and as far as possible to represent proportionately each department of physical science.

Where the requirements of the Institution would be better subserved by giving greater prominence to particular branches, a selection may be made by taking the separate departments from different sets.

It will be seen that some valuable instruments have not been included in either of the sets, but only those that are generally required; the purchaser can add such to his order, or make such other changes as he may desire.

All the articles in this Catalogue are, in size and quality, such as will make them suitable for portions of a most extensive cabinet. Our large Catalogue contains many instruments, in all departments, omitted in this simply because they are beyond the requirements of our high schools generally.

E. S. RITCHIE & SONS.

Manufactory, Brookline. Office, 149 Tremont Street, fronting the Common,
BOSTON, MASS.

Testimonials.

BOSTON, Aug. 10, 1857.

I take pleasure in bearing testimony to the great skill, faithfulness, and ingenuity of Mr. Ritchie, as a maker of Philosophical Instruments. Uniting an ample knowledge of scientific principles to large experience in the mechanical details of his profession, his work commends itself not only to institutions seeking apparatus for lecture-room illustration, but to men of science pursuing original research.

WILLIAM B. ROGERS.

AMHERST, June 5, 1869.

I have for many years been acquainted with Mr. E. S. Ritchie, as a designer and manufacturer of philosophical apparatus, and am prepared to speak in high terms of his intelligence and mechanical skill, as well as his courteous attention to those who apply to him for counsel or aid in his line of business. I am glad to look over the new catalogue of apparatus for schools, which Ritchie & Sons are just issuing, and to recommend it to the attention of all who wish to become purchasers. The improvements which they have made in many of the common philosophical instruments, have more than doubled their value. Teachers and experimenters may rely on the strict fidelity of the Messrs. Ritchie, in regard to the quality and adaptedness of the articles which they furnish.

E. S. SNELL,

Prof. of Nat. Philosophy, Amherst College.

EAST HAMPTON, June 5, 1869.

Mr. E. S. Ritchie has made a large amount of philosophical apparatus for me, at different times, and it has given me great satisfaction. In simplicity of design, accuracy of operation, and perfection of workmanship, it is not surpassed. His Patent Air Pump is a very great improvement upon anything of the kind before constructed. It easily makes a vacuum nearly as complete as can be obtained by the laborious process of the mercury pump. The exhibition of the electric light in the vacua produced by it is equal to that in the best Geissler tubes.

MARSHALL HENSHAW,

President Williston Seminary.

From Mr. John P. Gassiot, Vice-President of the Royal Society.

LONDON, March 7, 1859.

DEAR SIR: I have great pleasure in assuring you that the Induction Coil, which, through the introduction of my friend, Prof. William B. Rogers, you constructed for me, answers most admirably. With five of Grove's nitric acid battery cells I obtain eleven and a half inch sparks. The Vibrating Contact Breaker, which you subsequently sent, has enabled me to repeat all the experiments with my Vacua Tubes, while the three divisions in your Coil affords facilities for varying the experiments in a manner that can be well appreciated by those who have worked with this apparatus.

Believe me, dear sir, yours truly,

JOHN P. GASSIOT.

TO EDWARD S. RITCHIE, Boston, U. S. A.

UNITED STATES MILITARY ACADEMY, WEST POINT, N. Y., June 4, 1869.

The best portion of the apparatus in use in the Chemical Department at this institution, has been made under the direction of Mr. E. S. Ritchie, of Boston. In all respects, everything that has been received from him, whether ordered in person or by letter, gives complete satisfaction. His Electrical and Pneumatical Instruments are of unequalled excellence.

I have found Mr. Ritchie to be not only an entirely reliable gentleman, but one whose scientific attainments make him a valuable adviser.

H. L. KENDRICK,

Prof. Chemistry, &c., U. S. Military Academy.

CAMBRIDGE, Sept. 10, 1852.

This may certify that Mr. E. S. Ritchie is well known to us as a manufacturer of the best philosophical instruments used in academics and colleges. He is not content with supplying the usual apparatus found in all the catalogues, but he is ambitious to add to it new articles which illustrate fresh discoveries in science, or which excite a scientific curiosity. His integrity, his urbanity, and his skill all equally entitle him to the confidence of those who purchase or use philosophical apparatus.

JOSEPH LOVERING.

Hollis Prof. of Mathematics and Nat. Philosophy in Harvard College.

JOSIAH P. COOKE, JR.,

Erving Prof. of Chemistry and Mineralogy in Harvard College.

DARTMOUTH COLLEGE, HANOVER, N. H., May 22, 1869.

I take pleasure in bearing witness to the excellence of the Philosophical Apparatus manufactured by E. S. Ritchie & Sons. I have never found anything better in respect to accuracy of workmanship, and efficiency of operation. Their efforts to promote science by being the first manufacturers in the country to construct the Induction Coil, and the Holtz Electrical Machine, have deserved and obtained for them the regard of all American scientific men, and given them even a European reputation.

C. A. YOUNG,

Prof. of Nat. Philosophy and Astronomy.

NEW YORK, Sept. 1, 1857.

It is with great pleasure that I offer my testimony in favor of the excellent Philosophical Instruments constructed by Mr. E. S. Ritchie, of Boston. I have uniformly found them accurately and carefully made, durable and elegant. Mr. Ritchie seeks not alone to equal the best foreign instruments, but to surpass them, and to keep pace with the advancement of science. I have had repeated proofs of a characteristic possessed by Mr. Ritchie, which I feel confident will be appreciated, viz., the sympathy and interest he manifests with the success of the experimenter, associated with a pride for his reputation, punctuality, and a determination to accomplish his aims.

Respectfully submitted,

R. OGDEN DOREMUS, M. D.,

Prof. Chemistry New York Medical College, and College of Pharmacy.

ST. LOUIS, MO., May 28, 1869.

I am now using the Philosophical and Chemical Apparatus of E. S. Ritchie & Sons. Everything which I have seen of their manufacture has borne marks of mechanical skill, scientific knowledge, and the honesty which gives skill and knowledge their best results.

C. S. PENNELL,

Prin. of Mary Inst., a department of Washington University.

UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, July 10, 1857.

Having used with much satisfaction a variety of apparatus manufactured by Mr. E. S. Ritchie, I take great pleasure in bearing testimony to his ingenuity and scientific skill as a Philosophical Instrument maker.

R. E. ROGERS,

Prof. of Chemistry in the University of Pennsylvania.

ANDOVER, March 22, 1869.

From time to time during the last ten years, I have had occasion to purchase apparatus of Mr. Ritchie, and have found every article satisfactory. Mr. Ritchie is possessed of rare skill and ingenuity, and evidently takes pride in having every piece of apparatus in perfect order before it leaves his hands.

WM. G. GOLDSMITH,

Principal Punchard Free School.

YALE COLLEGE LABORATORY, June 17, 1859.

Scientific men in the United States, and teachers generally, are under many obligations to Mr. Ritchie, not only for the general superiority of his apparatus, but especially for his enlightened enterprise in undertaking many things for which we have before depended on Europe.

I have found Mr. Ritchie ready at all times to undertake commissions out of the routine of his business, relying for his reward upon the reputation growing out of such a course.

All the apparatus which I have had from Mr. Ritchie has been exceedingly well made, and has given me entire satisfaction. His stock of Physical and Chemical Apparatus is excellent. The pieces are well made, in good taste, and of reasonable price.

B. SILLIMAN, JR.

Extract of Letter from Prof. Forbes, of the University of Edinburgh.

EDINBURGH, 16 July, 1858.

MY DEAR SIR: . . . I have been highly pleased with the instrument. I have shown it in action to many scientific men, including Sir David Brewster.

I remain, dear sir, yours faithfully,

JAMES D. FORBES.

OFFICE OF SUP'T PUBLIC STHOOLS, CHICAGO, Feb. 15, 1859.

The Board of Education of this city has recently purchased of E. S. Ritchie, of Boston, one thousand dollars' worth of apparatus, for the use of the Chicago High School. In thoroughness of workmanship and elegance of finish, it is unsurpassed by any apparatus that has fallen under my observation. Its performance is in the highest degree satisfactory.

W. H. WELLS,

Superintendent Public Schools.

NEW ENGLAND NATIONAL BANK, BOSTON, JUNE 4, 1869.

MESSRS. EDWARD S. RITCHIE & SONS.

GENTLEMEN: In my opinion, your house may be relied on for faithfully performing all its promises and obligations; and this I declare, not only from a sufficient knowledge of it, but also from an intimate acquaintance with its members of longer standing than the establishment.

With esteem, yours truly,

THOMAS LAMB, *President.*

NEW AND VALUABLE
TEXT-BOOKS IN PHYSICS

FOR

GRAMMAR AND DISTRICT SCHOOLS, HIGH SCHOOLS,
AND ACADEMIES,


BY

W. J. ROLFE AND J. A. GILLET,
TEACHERS IN THE HIGH SCHOOL, CAMBRIDGE, MASS.

THE CAMBRIDGE COURSE IN PHYSICS

IN THREE VOLUMES :

- I. CHEMISTRY, \$ 2.00.
- II. NATURAL PHILOSOPHY, \$ 2.00.
- III. ASTRONOMY, \$ 2.00.

 New and revised editions of these books have been prepared, and the Series is now complete *in a permanent form*.

The *Electricity* of the old "Chemistry and Electricity" has been transferred to the "Natural Philosophy" in the new edition, and has been wholly rewritten, made somewhat briefer, and brought fully down to the present state of the science. There has also been added to the Appendix of the "Natural Philosophy" a chapter on the *Physics of the Atmosphere*, or *Meteorology*, containing all the recent discoveries and theories in this important and interesting field.

As thus revised, the "NATURAL PHILOSOPHY" is complete in itself, containing Mechanics (under which head are included Hydrostatics, Hydraulics, Pneumatics, Motion, Machines, etc.), Sound, Light, Heat, Electricity, and Meteorology.

The "CHEMISTRY" has been carefully rewritten and expanded, so as to fill the space occupied by the *Electricity* in the old edition. New chapters on *Crystallography* and *Organic Chemistry*, from the freshest sources, have been added, and the description of Elements has been enlarged.

This edition (June, 1869) gives the nomenclature as adopted by the London Chemical Society, as taught at Harvard College, and as generally used in scientific journals.

The new edition of the "ASTRONOMY" contains, in addition to the Astronomy proper, a chapter on the *Conservation of Energy* and an account of the *Constellations*, illustrated by 17 full-page *Star Maps* from Argelander.

These books are inductive in method, fresh in matter, simple in style, fully illustrated, and handsomely printed, and they exactly meet the wants of our advanced Seminaries and Academies, and of those High Schools which can devote considerable time to these subjects.

THE HANDBOOK SERIES

IN THREE VOLUMES :

- I. HANDBOOK OF CHEMISTRY, \$ 1.25.
- II. HANDBOOK OF NATURAL PHILOSOPHY, \$ 1.25.
- III. HANDBOOK OF THE STARS, \$ 1.50.

These books contain (aside from the Appendix) respectively 159, 230, and 159 pages, in clear, open type, *with no fine print*, and they treat of all the topics usually included in school manuals of these sciences. The more theoretical portions of the subject are discussed briefly in Appendixes, and descriptions of apparatus and directions for performing experiments are added. *Omitting* the Appendixes, the books are not too difficult for the upper classes in Grammar and District Schools. *With* the Appendixes, they are exactly adapted to the wants of those High Schools and Academies which have not time for larger books.

They are *not* abridgments of the larger works by the same authors, but are wholly new and independent books, differing from the others in the selection, arrangement, and treatment of topics, so far as was necessary to fit them for a briefer and easier course of study. They are simple in style, and eminently *practical*, yet thoroughly scientific, and giving the results of the latest discovery and research. They are sure of a hearty welcome from teachers who desire books that shall be brief without being dry, and easy without being puerile.

* * * Circulars, containing notices and testimonials from eminent teachers, will be furnished on application. Copies for examination will be supplied at one half the advertised price, with twenty-five cents additional for postage. Special terms will be made for the introduction of any of the books.

WOOLWORTH, AINSWORTH, & CO.,
117 WASHINGTON STREET, BOSTON.



LIBRARY OF CONGRESS



0 003 648 028 2